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The Importance of Technical Control in the Glass Industry

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(*Written for* THE GLASS INDUSTRY)

THAT some one discovered by chance thousands of years ago that the sands of the shore, mixed with natron and other natural minerals and subjected to the heat of the fire, fused to a mass which we call glass; that our forefathers mixed various raw materials and melted them in crucibles or pots to make glass, does not warrant the manufacturer of the present day to produce this indispensable article by "rule of thumb" methods when he can avail himself of contributions already made by science and of the active cooperation of the scientist. Careful control is practiced in some plants but many still operate by the "rule of thumb."

ALEXANDER SILVERMAN.

TEMPERATURE CONTROL.—The chemist learns early in the course of his training that an increase of ten degrees centigrade virtually doubles the speed of a reaction. In the majority of glass plants of this country the variations in furnace temperature far exceed this small amount. While many factories have installed pyrometers, pyrometric control is by no means universal. The experienced glass maker of the old school will say that he can tell by rod or finger proofs when the glass is ready for working. Careful temperature control, together with a check on composition, which will be discussed later, produces a highly desirable constancy of conditions and product. Some glass makers will tell you that they have tried pyrometers and thrown them out because the ——— things didn't work. One must choose the right type of pyrometer for his purpose, then have it compared with a standard pyrometer from time to time.

The metal parts in pyrometers undergo change through constant exposure to high temperatures but a pyrometer expert can furnish corrections, to be made in the temperature readings. Even optical pyrometers in which an electric bulb is used will give incorrect readings after a time, due to a change in the lamp filament. These, also, must be compared with standards occasionally.

Unchecked pyrometers may be off by several hundred degrees. Properly selected and carefully handled pyrometers, checked against standards, will give readings accurate to within ten degrees or less for high temperature work.

The use of pyrometers is not only to be recommended for melting-furnace control but also for the lehrs or annealing ovens. That there is an enormous annual loss to the industry through breakage of improperly annealed glass cannot be questioned. Wrong composition is responsible for much breakage but improper annealing will increase the figures on the debit side of the ledger still farther.

In such a general paper as this one, room for the discussion of types of pyrometers and problems peculiar to special branches of the glass industry is lacking. You should be able to find a technical expert in your district who can properly advise you concerning your particular problems.

COMPOSITION OF RAW MATERIALS.[1]—While some raw materials used in glass making run fairly uniform many of them have quite a range of variation.

SAND.—Sand may contain iron oxide from a trace to 1%; alumina up to 7 or 8%; lime up to 0.5%; alkalies up to 3.5%; matter lost on ignition up to 4%, together with small quanties of magnesia, oxide of manganese, etc. The appearance of the sand, alone, is no criterion. Again it may be coarse or fine, the grains may be round or angular. The behavior of the sand will depend on its composition and on the size and shape of the grains. Sudden change from one kind of sand to another without considering these

[1] A. Silverman, The Importance of Analysis in Purchasing Raw Materials for the Glass Industry, J. Am. Ceram, Soc., vol. 3 (1920), pp. 26-34.

facts may produce undesirable and unexpected results.

SODA ASH AND PEARL ASH.—Most manufacturers use 58% dense soda ash. This occupies less space than light soda ash and its relation to other raw materials in the batch will be different during fusion. Soda ash may contain as much as 1% salt and 1% salt cake, together with small quantities of other impurities. The impurities may prove unobjectionable for some kinds of glass and quite objectionable for others.

Pearl ash is a very uncertain article to-day. While just before the war, refined pearl ash was practically pure potassium carbonate, at present one is apt to find very impure material in the majority of cases. The writer had occasion to purchase some a few days ago and the analysis showed only 34.5% potassium carbonate, with caustic potash 31.6%, potassium chloride 2.3%, silica 1.3%, volatile matter (water, etc.) 29.8%, etc. Depending on the source, pearl ash may contain as much as 6% soda ash, 10% potassium chloride, 30% potassium sulphate, etc.

SALT CAKE.—This may contain up to 5% salt, 1.5% sulphuric acid, 1.25% oxide of iron and alumina, 0.5% lime, as much as 3% water, etc.

NITER.—Niter, unless double refined, may contain as much as 2.5% salt, 1% salt cake, 4% salt peter, etc.

LIMESTONE AND LIME.—Limestones may vary in composition from 54% to 99½% calcium carbonate, 0.1% to 45% magnesium carbonate, a trace to 1% iron oxide and alumina, 0.1% to 2% silica, etc. Burnt limes vary from 55% to 98% lime, 0.1% to 43% magnesia, 0.1% to 1% iron oxide and alumina, 0.1% to 1% sulphur trioxide, etc. Hydrated or slaked limes run from 47% to 98.5% calcium hydrate, 0.1% to 41% magnesia, 0.2% to 1% iron oxide and alumina, etc. They may contain as much as 20% or more water and other material which is lost on heating the batch.

MANGANESE DIOXIDE.—This varies from 70% to 86% in manganese dioxide which may contain from 0.25% to 4% iron oxide, 0.5 to 3.85% silica, 1.75 to 13% water, besides containing alumina, lime, etc.

FELDSPAR.—Here there is a range of from 65% to 72% silica, 16.7% to 21.1% alumina, 8.1% to 10.6% potassium oxide, 1.1% to 8.3% sodium oxide, 0.1% to 0.5% lime, 0.05% to 9.3% ignition loss, etc. Variation in composition of feldspar and fluor-spar might seriously affect the color of opal and alabaster glasses.

WATCH THE ANALYSIS.—The composition of other glassmakers' chemicals in less common use need hardly be discussed in this article. It must be evident to the manufacturer that variations in composition may yield disastrous results. He should have the factory chemist analyze every shipment received. If he does not have a chemist he should ask the manufacturer or dealer from whom the material is purchased to furnish an analysis. Dealers realize that the composition varies and responsible parties will gladly furnish analyses. The composition is so important that if the analysis is not available a representative sample should be sent to an outside chemist for examination. A chemist who is familiar with glass works practice can advise the manufacturer how to substitute new materials for old if the composition is different, so as to get a uniform glass.

MAKE CHANGES CAUTIOUSLY.—If you are getting raw material from a certain source do not substitute a cheaper one pound for pound without the advice of your chemist. The new material may work very well if proper corrections are made in the batch. If not, trouble may confront you. The monetary losses, sustained through blind substitution of one raw material for another in the glass industry, are enormous.

MIXING AND CULLET.—Raw materials are still mixed by hand in many plants. The writer feels that more uniform mixing results in a machine of the concrete-mixer type. Machines now built specially for the glass industry are so constructed as to permit of the weighing of raw materials and their direct delivery to the mixer. A fixed period of time should be allowed for mixing a certain type of batch. Subsequent to mixing the batch may be transferred to batch carts, mechanical conveyors or to storage bins.

Cullet abounds in such a variety of sizes and shapes that it is desirable to crush it to uniform size. Chrome-steel jaw crushers serve the purpose. The glass should be crushed to quarter-inch size. A definite weighed quantity should be added to the batch; in fact, the writer prefers to add his cullet to the batch before mixing same, as it assists in the mixing.

Uniformity in results will obtain with such practice. Large lumps of dense cullet are bound to have a different melting rate than light cullet and this may result in cordy glass.

COMPOSITION OF THE BATCH.—With the enormous demand which now exists for glass, some manufacturers are inclined to increase production by adding more soda ash to the batch to obtain a greater yield from the tank in a given time. This is poor practice, as it results in a glass which becomes coated with a dull film on exposure to moist air. It is better to limit production, or construct additional tanks than to turn out an inferior product.

A carefully balanced batch, properly controlled during mixing and the melting period will do much to establish the manufacturer's reputation. The introduction of soda ash increases the coefficient of expansion of the glass and greater breakage results.

If you have a good batch which has worked nicely do not change it. If you know that your raw materials are uniform in composition, and you will properly control mixing and the temperature of furnaces and lehrs, no changes are necessary. If the batch does not work satisfactorily and you want to improve it and are not in a position to do so alone, consult someone who can properly advise you. The writer has in mind the experience of a manufacturer whose glass was cordy. He consulted a friend in the business, who advised him to add salt as a stirring agent. The manufacturer added ten pounds per hundred of sand, an excessive amount, and filled half a dozen or more pots with the batch. A lot of salt water accumulated on the top of the glass, attacked the pots, injured one of the workmen who did not know how to handle it, and corroded the moulds. Under proper conditions the salt might have served the purpose. A pound per hundred of sand would have been ample.

DECOLORIZERS.—With the shortage of manganese dioxide during the war many manufacturers began to use selenium as a decolorizer. Some did not know how and spoiled large

quantities of glass, sometimes whole tanks. While one is told to use from a quarter to half an ounce of selenium per thousand pounds of sand for soda-lime tank glass, so much depends on the iron content of raw materials and on furnace conditions that no general rule can be established. It is necessary to study the case before prescribing. Even with manganese dioxide, the grain size and manganese content must be taken into account to get uniform results. One cannot simply substitute one lot of manganese dioxide for another, pound for pound, without considering these important facts.

CASED WARE.—Cased ware manufacturers frequently suffer heavy losses from breakage. This is usually due to unequal coefficients of expansion in the two glasses. The old glass maker would gather one glass over the other and draw a rod. Then he would reverse the order of the glasses and draw another rod. If neither cracked or scaled the combination was considered satisfactory.

The chemist is able to anticipate results by calculating a casing batch from the cubical coefficient of expansion of the glass which is to be cased. Where this principle has been applied the breakage has been reduced to a minimum. While the calculations are being made, pots formerly used for prolonged experimentation are available for the manufacture of other salable ware.

FUEL.—The control of air and steam in artificial gaseous fuel production is valuable. In one plant, where considerable trouble was experienced, the problem was finally referred to the chemist. Placed in charge, he analyzed the artificial gas and flue gases, and soon regulated the operation of the producer so that uniform results followed. Carbon dioxide recorders and stack draft gages are valuable when understood. The annual saving effected in the case cited was many times the chemist's salary.

CONCLUSION.—Control and standardization are reasonable and logical. The technical man takes cognizance of their value. Ask manufacturers who have gone at the matter thoroughly and they will tell you that their ware has improved and that the profits and their reputation have grown. General standardization and control must result in the saving of millions of dollars in the glass industry and improvement in the quality of the product.

Some Principles in Glass Pot Manufacture

By C. H. KERR

(*Written for* THE GLASS INDUSTRY)

SUCCESS or failure in pot service is frequently the measure of success or failure attained in the manufacture of glass and especially is this true of those branches of the glass industry in which large scale production is essential to economical operation. Many are the cases on record where the attainment of anything approaching profitable operation was prohibited by the failure of pots. The old glass men can recite case after case where promises of efficient production were cut short because the pots would not stand up. Parenthetically, it might be well in the beginning to admit that while the custom of blaming all troubles onto the pot house is very often correct, still there are other causes of failure. However, it has become so habitual to point to the pot house whenever troubles appear that one can hardly be blamed for following this path of least resistance and blaming the pots.

Whatever defence may be made of the quality of the pots or whatever blame may be attached to pot failure as a limiting factor in glass manufacturing of to-day few would care to maintain that any other single point is equal in importance to a supply of suitable pots.

In our general discussion relating to pots it will be understood that tank blocks are included also. In general the same considerations that apply to the production of good pots apply with slight, if any, modifications to the making of satisfactory tank blocks. What is a tank but a pot built sectionally and on a grand scale? Because of its size and the differences in method of operation from that of the pot, some modifications of theory are necessary but the fundamental problems underlying the making of a good pot are identical with those governing the manufacture of satisfactory tank blocks.

Careful workmanship is the most vital consideration in pot making. In all clayworking processes the care exercised in preparing the mixture, in forming the product and in drying and burning are of fundamental importance but in no other branch of the clay industry is the thoroughness and efficiency of the workman of relative importance equal to that in pot making. It is possible to make a fairly good pot from only moderately good materials or to make a fair pot from rather inferior materials by the most careful workmanship, but in the absence of thorough and painstaking work the best of raw materials will produce only a poor pot. Care throughout the process from the picking over of the raw materials through the grinding, mixing, tempering, pugging, forming, drying and burning are essential and failure to observe the most minute precautions may and often does result in disaster. So in any discussion of materials or of methods let it not be forgotten that care throughout the process of building the pots is of greater importance than any of these other considerations.

In pot discussions the first point usually brought up is the pot batch. As a matter of fact the batch is a consideration of relatively lesser importance. Everyone familiar with the production of good pots realizes that a great many formulæ, many of them varying considerably from the average, may be written down and any one of them will produce a good pot and frequently it will be very difficult to say which one is best. There are certain limitations in each particular instance which must not be transgressed but within those limitations there is a great deal of give and take in balancing one property against another and substantially the same general results may be obtained in several different ways.

In general it is helpful to consider pot materials as falling into three broad groups, the bond clay, the body clay of

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medium plasticity and the refractory skeleton clay. Sometime one clay may be a natural mixture of two or possibly all three of these types, but usually it will be found that better results are secured by mixing the simpler type clays than by using natural mixtures. Not that man can beat nature in accomplishing a thorough mixture of materials! But from one part to another of a given deposit the proportions of the things which nature had to mix may vary considerably.

The bond clay is typically a very fine-grained, very plastic clay of high bonding power and of rather low fusing point. The mistake is often made of condemning a good bonding clay because, when tested by itself, it fuses down and bloats badly at a temperature even below the maximum temperature at which the pot may be used. Such tests of fusing point and bloating of bonding clays are of doubtful value and may be very misleading. It is another one of those many cases where a little knowledge is a dangerous thing. In fact, there is much room for question as to the possible value of any tests of a bond clay when the clay is tested by itself. Certain comparisons from clay to clay may be made and certain general indications obtained but a bond clay may best be tested in a standard mixture in which its binding properties come into play. From the indications to date it seems that the best bonding clays are rather inferior materials except when put to work in bonding other clays.

The body clay is typically a good fire clay of medium to poor plasticity and fairly refractory, fusing at, say cone 31-32. Too much stress should not be put on refractoriness, for other desirable properties are almost sure to be sacrificed if too great refractoriness is demanded. Good working properties, when incorporated into the pot batch, are fundamental and for these properties we must depend very largely on the body clay. Furthermore, in the body clay, as in the bonding clay, consideration must be given to the other materials with which it is to be used and reliance should be placed chiefly upon tests made with complete mixtures, rather than on data obtained from one clay by itself.

The third type of clay, the refractory skeleton clay, is more often ignored, but it is of great importance, especially in its effect upon pot life. The typical clay has little or no plasticity and is highly refractory. Refractoriness is, however, of less importance than chemical composition in its relation to the glass batch to be melted. The type of refractory skeleton clay should be chosen very largely on the basis of its solubility in the molten glass with which it is to be in contact. There are two diametrically opposed possibilities. One is to make the pot as insoluble as possible in the molten glass and the other is to make it rather easily soluble on the theory that pieces of the pot, when they do become detached and float into the glass, will dissolve and disappear. The decision between these two methods must be made on the basis of each particular case, but usually the latter idea will be found to yield better commercial results, even though it may be weak theoretically and hard to defend.

In any clay to be used for pot making one of the most important constituents is the iron. In some glasses, notably optical glass, the coloring effect of the iron is decidedly objectionable but even where the discoloration of the glass is of little or no importance, the presence of iron in the clay is a great disadvantage. The glass batch ingredients in process of melting and the molten glass also, exert selective solubility and start the attack on the pot wall through its most vulnerable point, the iron, in whatever form it may be present. This starts the breaking down process and the pot soon becomes honeycombed and rapidly approaches the end of its usefulness.

But the amount of iron alone is not a safe indication of the danger from this source. The state of subdivision of the iron is of considerably more importance than its amount, provided the amount is not greater than say 2, or even 3, per cent. If it is in very fine-grained form and uniformly distributed throughout the clay mass it is far less dangerous than if it is present in lumps of any appreciable size which must necessarily be in spotted locations rather than homogeneously distributed through the mass. Under American conditions of manufacture and, of course, using American raw materials this point regarding distribution of the iron is of first importance. The amount is much less important than its uniformity of distribution. Of course there are cases, like those of special optical glasses, in which the amount of iron must be very small, whatever the state of distribution may be.

Any pot batch to be most successful must be as homogeneous as possible and to show consistent and uniform pot records the clays used, as well as the mixing of them, must be as nearly free from variation as possible. Any one clay is apt to vary more or less from shipment to shipment and especially from year to years as the mine or pit is worked out into new parts of the deposit. The best way of minimizing the variations in pots due to such variations in the clays themselves is to use two or more clays of each type in the batch and thus employ a rather large number of clays, rather than a very limited number.

There are very obvious reasons why any pot house might wish to use only two or at most three different clays in the batch and nothing could be simpler than to have only one clay to deal with, but it has proven to be very short-sighted policy to rely upon the uniformity of any one or two materials. When the product of a different part of the deposit is received, always without warning of variation, and it proves to be a little different from the former material, then troubles appear. The only safe policy is to use several clays in the batch, preferably some five or six, and then any variations which may occur in one of the materials will have relatively little effect upon the properties of the entire mixture.

Another important point, largely a somewhat different phase of the question of homogeneity, is the proper sizing of the grog or non-plastic material in the mixture. The coarser the grog the greater the tendency toward higher porosity and lower vitrification of the mass and conversely the finer the grog the greater the density and the greater the vitrification effect. But aside from these questions of greater or less porosity or vitrification is the more important question of homogeneity throughout the mixture and a proper sizing, especially a proper gradation of sizes, is vital in the securing of good results.

Frequently, all of the finer grains have been removed from the grog or on the other hand all of the coarse grains beyond a medium coarseness, but it seems probable that both methods

were wrong, at least in comparison with the most desirable practice of insuring a proper proportioning of all the different sizes from coarse to very fine. Undoubtedly the great expense of separating the grog into several sizes and carefully proportioning those sizes in accordance with predetermined requirements would be amply justified in many applications in the glass industry. This is one of the developments that the future will turn into universal practice. A remarkable amount can be accomplished in governing the proportion of different sizes in the grog by control of the grinding process. By regulating carefully the rate of feeding and the speed and pressure during grinding a great deal can be accomplished.

Pots, as ordinarily made, contain a considerable proportion of pot shell, obtained from old used pots. This material varies exceedingly in its nature and especially in its porosity and in the amount of glass or of alkali which has penetrated or diffused into the pot wall. The porosity of the pot shell varies from zero to thirty per cent, or even more. Near the top or brim of the pot the porosity will run from zero to about 5 per cent. It is customary to throw away the glazed top edge of the pot wall but the above figures apply to the section just underneath and which is used for pot shell. Pot shell from the side walls will vary from 5 or 10 per cent to about 20 per cent, the lower figures being obtained near the top section or the outer surfaces and the higher figures from the center of the walls and especially down toward the knuckle. Shell from the pot bottom will run from 15 to about 30 per cent porosity.

It certainly seems poor logic to use such variable material in the production of an article that requires such extreme homogeneity as is demanded of a glass pot, yet just such variable material is used, universally. The obvious answer is to use an artificially prepared grog which shall be uniform in character and shall possess just such properties as the particular use may require. The production of such artificial and uniform pot shell will, of necessity, be an item of considerable expense, especially as compared with the regular pot shell which costs nothing except the pay roll cost of the pot shell "pickers," but, if properly done, the results would amply justify the cost of making a uniform pot shell. It is highly probable that one of the outstanding developments of the near future in the art of pot making will be the production of a uniform artificial pot shell to replace the variable product now obtained from old pots.

The process of pot making as ordinarily practiced is the same as it has been for many years. The manipulations in hand building have undergone no appreciable changes in generations and there is no denying the fact that a pot when well made by hand, in the usual manner, is an excellent product. But very frequently pot failures are due to faulty building. It is a matter of very precise regulation to accomplish a proper junction between newly added clay batch and the material previously built in. Unless conditions are most carefully regulated the junction between the new and old clay masses will be weak and either a crack will form later or solution by the molten glass will be rendered easier at that point and thus cause failure of the pot. By the usual process of covering with wet cloths to maintain the surface in proper condition to unite with the next spell it is possible, but very difficult, to insure a proper union. This has been a constant source of trouble and it has doubtless been responsible for far more trouble than has been attributed to it.

One way of avoiding the difficulty of a proper union between successive spells is to build the pot up all at one time inside a form to support it during the early drying stages and considerable success has been had with such a procedure. But there have been enough difficulties encountered with the one-day building process to prevent its universal adoption.

Another avenue of escape lies in the adoption of the casting process. There is, of course, no possibility of danger from trouble with insufficient union between different parts. If the mixing is properly done, the whole fluid mass is thoroughly homogeneous and moreover the raw clays actually penetrate the interstices in the non-plastic constituents, thus forming a bond which cannot be duplicated in any plastic working operation. The intimacy of mixture accomplished by the slip casting process is quite ideal and presents a very strong argument for the more general use of the process in the pot-making industry. If the liquifying agents are properly selected and properly proportioned for the batch used it is quite possible to reduce the necessary water content and the subsequent shrinkage to figures quite commensurate with corresponding figures based on the ordinary plastic mass and there is plenty of evidence that, if correctly handled, a cast pot will stand even more rapid drying than a plastic-built pot. There seems little doubt that the casting process, as applied to pots, will be very greatly extended beyond the limited use of to-day. There are so many considerations favorable to the casting process that it is well worth fording a river of trouble to arrive safely on the other shore.

Reverting now to a consideration of the plastic built pot, as well as the cast pot, there is a practice, rather extensively followed, which is often scoffed at from a scientific point of view, but which is capable of ample defense on the ground of practical results. We refer to the practice of tamping pot bottoms when they reach an almost leather-hard condition and continuing the tamping daily until the surface is nearly dry. Considerable experience is needed to properly estimate the appropriate tamping period but when properly practiced, tamping does render a pot more resistant to the solvent action of molten metal and thus increases, not only the quality of glass produced, but also the life of the pot.

Another practice which has been observed, more or less, for a number of years is that of lining the pot with a relatively thin layer of a mixture designed to be especially suitable for contact with the particular variety of glass to be made, while the body of the pot is made as a refractory shell to stand the general furnace conditions encountered. This practice, while it was uncertain in its early history because of the great irregularity in results, sometimes highly successful and sometimes highly disappointing, has come to be a pretty satisfactory way of handling certain difficult cases of pot manufacture. Quite frequently the sort of composition that is best suited to the manufacture of a certain type of glass is one that is very difficult or even impossible to make into an entire pot because of failure to withstand the furnace conditions imposed and in such cases the proper mixture

used as a lining inside a suitable refractory shell may prove to be highly satisfactory.

Oftentimes a pot lining is made of the same composition as the outside shell, the lining differing from the shell only in the fineness of grinding. While it is probably true that some improvement may be attributed to the use of a finer lining, still it seems probable that the chance of further improvement is being lost. In most, if not all, cases a suitable variation in the composition of the lining might well be made with improvement in pot service. If the trouble and expense of a lining is to be borne anyway the argument is very strong to modify the composition of the lining to best meet the solvent action of the molten metal. Certainly the required functions of the main shell of the pot in withstanding furnace conditions and of the inside surface of the pot in withstanding the action of molten glass materials and glass itself are fundamentally different and much improvement can often be accomplished by a properly designed lining.

In the drying process great damage is frequently done and even more frequently are very unnecessary and even useless precautions taken. There is no fundamental reason why the drying of a large clay mass, such as a glass pot, should take many weeks or even months. There is no reason why, under satisfactory control, the drying should not be accomplished in a relatively small number of days, depending upon the size and design of the pot. In fact, it would seem that a really good control of drying would necessitate that the drying be accomplished quickly.

There are two chief points commonly overlooked in pot drying. The first is the precaution to avoid evaporating water from the surface more rapidly than it is brought to the surface by capillary action from the interior of the pot wall. A relatively high temperature throughout the drying is almost a prerequisite of control on this point, and higher temperature means much higher relative humidity to keep down the rate of surface evaporation to a point commensurate with the rate of replacement of surface moisture by moisture brought from within. The second point is a thorough, final drying before the pot is arched. In the ordinary air-dried condition a pot contains from 3 to 5 per cent moisture or even more, and it takes a very severe hot room treatment to reduce the moisture content to less than 1 per cent. When a raw clay mass of any sort is being heated up it is very weak indeed and the expulsion of water too rapidly may easily break down the minute bonds throughout the mass. For most successful pot results this final expulsion of moisture must be carefully controlled and accomplished at a temperature below the boiling point.

About the general question of pot burning, volumes could be written, yet it is the most neglected part of the life history of a pot. There are two points, however, which deserve special attention. The first of these considerations is linked inseparably with the composition of the pot, for without a proper regulation of pot mixture it is impossible of accomplishment. The pot burning should always be carried to a temperature at least equal to and preferably somewhat above the temperature of the furnace into which the pot is to be set. It will be admitted at once that good results have been secured from pots arched at temperatures much below the temperature of furnace use, but that is neither proof nor evidence that a proper burning, prior to use, with suitable modification of batch if necessary, would not have produced even better results. There seems no likelihood that the present general practice of relatively low arching temperature will continue indefinitely and be accepted as good standard practice.

Another point in pot burning that is now receiving considerable attention and with profitable results is the question of the silica inversions. The typical glass pot contains some 70 per cent silica and the silica inversions and consequent volume changes are of the utmost importance in securing proper pot service. In many uses, the rather high silica pots have proven very successful and with such pots especially is it necessary to control the burning most carefully at the inversion temperatures. There are on record many cases of complete failure which have been due to nothing else than disruption of the pot by silica changes. The mere fact that a pot does not crack and practically or actually fall apart gives no assurance that damage is not resulting from this cause.

No general resumé of the art of pot making would be sufficient if it did not refer to the possibility or even certainty of success to be attained in the future by the use of new ingredients. Among the materials that are commercially available now or rather easily obtained may be mentioned zirconia, sillimanite and some of the artificial spinels. It would seem a fair gamble that some of the newer refractory materials now being developed will show successful application in pot making and it is not unlikely that the most important evolutions in pot making will come through the use of new refractory materials. Obviously the use of certain fluxes to promote a proper bonding action would be a fruitful field for research.

Whatever the nature of the pot batch composition, whether it be a mixture of the typical pot clays or with new refractories added or substituted, one consideration will always be of prime importance and that is necessity of a homogeneous composition throughout the mass. The burned or nonplastic part of the mass should, beyond question, be of exactly the same composition as the raw or plastic portion and to fully accomplish this end would necessitate the making of a special burned product to be used in its entirety and alone, as the burned portion of the batch. It is fruitless to expect that the best results can be secured when different grains in the pot wall are radically or even moderately different from other grains or portions of the pot.

We Want Your Co-operation

Articles on live technical and practical subjects that will be of interest to glass manufacturers, factory managers, superintendents, chemists, engineers, production managers, purchasing agents and other glass works executives are cordially invited from those qualified to submit sound and informative contributions.

Comment on, and criticism of any statements appearing in THE GLASS INDUSTRY with which our readers do not agree, will also be welcomed.—EDITOR.

Annealing

By CHESTER L. SHARP[1]
(*Written for* THE GLASS INDUSTRY)

IN 1858 Charles Tomlinson considered the manufacture of glass one of the Black Arts. In his book, "The Five Black Arts," on annealing he writes: "The bottle is then lifted by the neck on a fork by a little fellow about ten years of age, and carried to the annealing arch, where the bottles are placed in bins above one another. This arch is kept a little below melting heat till the whole quantity, which amounts to ten or twelve gross in each arch, is deposited, then the fire is allowed to die out."

Annealing is the process of gradually cooling glass in such a manner as to eliminate strains. Glass will resist crushing in a high degree. Breakage originates from the inside, and if the strain is not removed, the glass article will break into a large number of pieces. Of course, if glass is poorly annealed, it is more likely to break than if properly annealed. There are some exceptions to this rule, because the designed purpose of the glass article may be such that stresses may be of such a nature as to be removed when the glass article is used. Take the case of a lantern globe, where the exterior of the globe is in compression and the interior is in tension. When the globe is used, the interior is heated and, of course, the inside is expanded, which removes all or a large amount of stress. All glass cannot be made into lantern globes, and for this reason the subject of annealing of glass is very important as well as interesting.

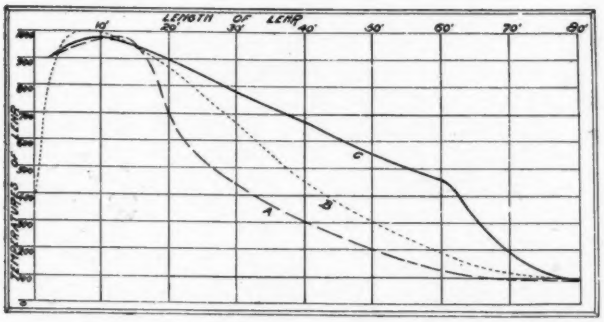

FIG. 1. THREE TEMPERATURE CURVES OF THREE DIFFERENT MUFFLE LEHRS.

"In the good old days," annealing was done by the use of the arch or oven as described by Mr. Tomlinson. Later, a number of arches were thrown together, and a set of pans used. This was a direct-fired lehr, and the temperature was controlled to some extent by the "squirrel tail." By this method, the products of combustion came in contact with the glassware, and a white deposit was left on the articles. This was commonly called "sulphur." Glass manufacturers disliked this scum or deposit, so the direct-fired lehr was followed by a tunnel lehr containing an endless chain of pans and muffled fire boxes. Glass articles may be annealed in ovens, but this method is too slow for present day production of bottles and other ware. As muffle lehrs are at present in general use, we will discuss this method of annealing.

Glass is a poor conductor of heat, and when quickly cooled, the outside becomes cold first, because the outside has had the effect of shielding the inside from the cooling effects of the air. For this reason, the outside surface of narrow-neck ware, etc., should be brought up to the temperature of the inside after being placed in the lehr. This removes strains. Then, the outside should be cooled at the same rate as the inside of the glass article, until 400 to 450 degrees F. has been reached. Of course, this point will vary for different kinds of glass. The thicker the article, the greater the strain between the inside and the outside of the article. A very thin glass article requires very little annealing, because the inside lays so close to the outside, it cools approximately at the same moment. Some glass can be completely annealed between 1,000 and 600 degrees F. It is assumed in this discussion that soda-lime glasses can be annealed between 975 and 400 degrees F. Of course, the composition, thickness, and shape of the glass articles must be taken into account in establishing the proper temperature for the beginning of annealing. At the discharging end of the lehr, the articles should be cool enough to handle.

Figure 1 shows three temperature curves, of three different muffle lehrs. Curve A represents the temperature found in the usual muffle lehrs that seem to do fairly satisfactory annealing for ordinary ware. Upon closer inspection, through polarized light with the microscope, a very large per cent of ware annealed through a lehr with a temperature curve such as this, shows a large number of strains, because of the sudden drop of 530 degrees in fifteen feet, which occurs just back of the muffle chamber.

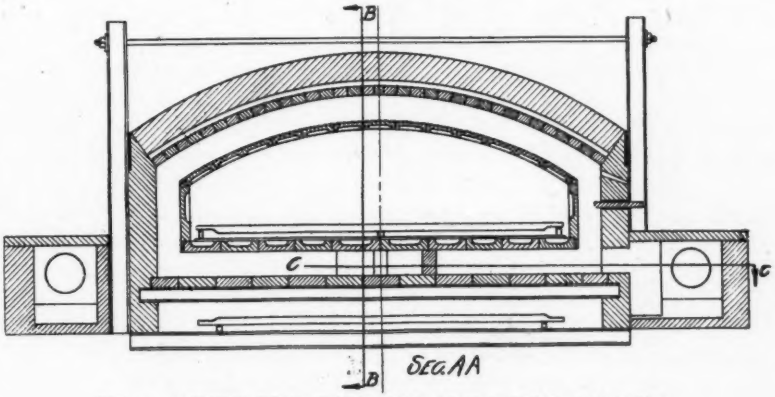

FIG. 2. MUFFLE LEHR WITH SIDE COMBUSTION CHAMBERS.

Curve B represents a curve which a lehr manufacturer thinks is ideal, and claims they are able to obtain these

[1]President, the Sharp-Schurtz Company.

temperatures with their new muffle lehr construction. This is a direct copy of their temperature curve, as shown in their booklet. You will notice that this curve starts at 400 degrees, and climbs very quickly to 1,000. From this curve, we would judge that they place their glassware in the lehr at about 400 degrees, and quickly raise it to 1,000, and after the glass has passed the ten foot mark in the lehr, it is gradually cooled until it comes off at the end of the lehr.

We believe Curve C is the most efficient annealing curve. All glass men know that glass articles may be quickly cooled after they have been gathered from the tank at around 1,900 degrees F. until they reach about 900 or 950 degrees F. without injury. This cooling can be rapidly done by placing cold air blowers on the glass articles, while in the molds or as soon as placed on the cooling bucks. We believe that the average glass article should go into the lehr not cooler than 900 degrees F. and be gradually raised until it passes the 950 degrees F. If the critical high point of annealing certain glasses is 800 or 850 degrees, then the arrangement should be made so the temperature of the lehr at the point where the glass article first touches the lehr pans should be 800 or 850 degrees.

In cooling from this point on, lies the value of annealing. By bringing the temperature up to 950 degrees F. this brings up the temperature of the outside of the article to the temperature of the inside, and then it should be gradually cooled until the article reaches from 400 to 450 degrees.

It has been proven that after 450 degrees F. has been passed, glass may be cooled as fast as possible, because solidification in the glass is complete, and no further strain can be set up. For this reason, Curve C shows a very decided drop after reaching 450 degrees.

If Curve A were correct, and the usual muffle lehrs are doing correct annealing, it would not be necessary to have a lehr longer than 40 or 45 feet. If Curve B were correct, this lehr manufacturer should only build his lehrs 50 or 55 feet long. Compare these two curves with your experiences.

Over ninety per cent of the ware received at our laboratories shows that the glass articles (mostly bottles), are not tempered in the bottom. This can partly be accounted for because a large number of the present muffle lehrs have their fire box directly over the lehr pans. For this reason it is impossible to run the bottom of the muffle chamber as hot or hotter than the top.

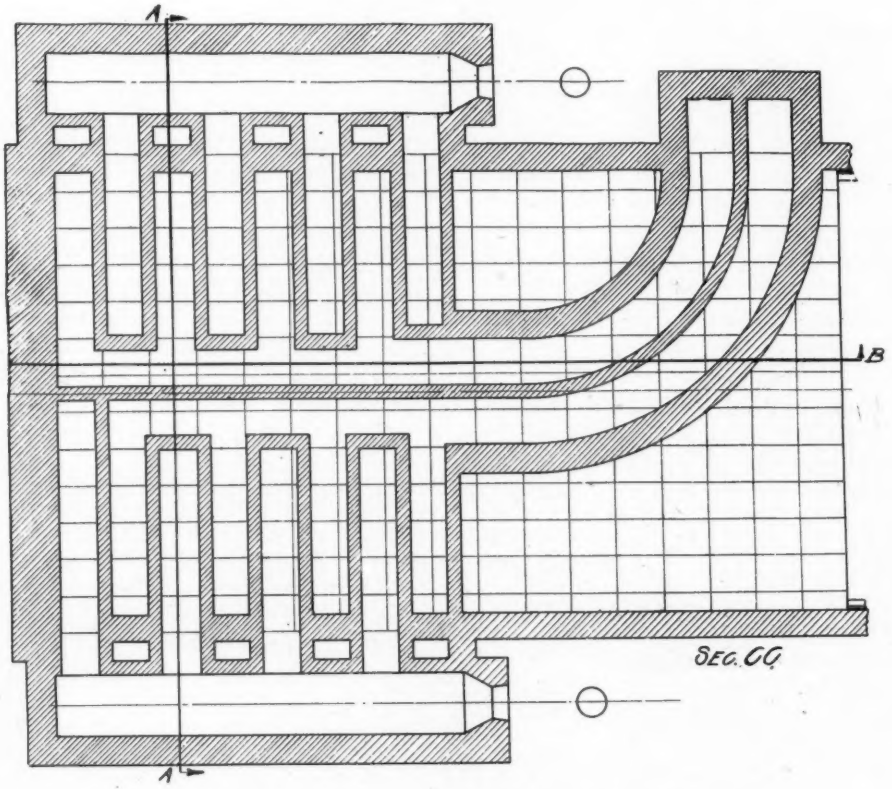

FIG. 3. SHOWING THE CONSTRUCTION OF THE FLUES BETWEEN PANS.

Figure 2 shows a muffle lehr with side combustion chambers. By placing the combustion chambers on the side, it is possible to run the bottom of the lehr chamber hotter than the top. By this method, a glass manufacturer is able to properly anneal bottles and glass articles having heavy bottoms. The burners used in connection with these combustion chambers are of special design for producer gas. Natural gas or oil can be used successfully with this type lehr. The air used in the burner may be cool or preheated. The burners are placed in the floor within handy reach of the operator. The flame is thrown towards the front of the lehr. The fire divides and passes into the lehr under the

lehr pans and up the side muffles, over the top of the lehr chamber, down the opposite side muffles, and under the pans into the flue to the stack.

Another advantage of the side combustion chambers is that this method provides a non-tarring and non-sooting firebox and flues. The producer gas is taken out of the top of the gas tunnel. If any soot is carried into the combustion chambers, it is burned and used as fuel.

Figure 3 shows the construction of the flues between pans. You will notice that each side of the lehr has a separate stack flue. If the direction of the wind causes one side of the lehr to run colder than the other, this can be overcome by using one of the stack dampers and increasing the opening in the stack flue; this will increase the draft on one side of the lehr. By increasing the draft on one side, more heat is pulled into this section of the lehr, and the operator is able to maintain a uniform temperature throughout the lehr.

Some of the muffle lehrs on the market with top combustion chambers, place the producer gas burners over the lehr. Whenever the operator desires to increase or decrease the amount of fuel desired, it is necessary for him to climb to the top of the lehr. This is an unhandy arrangement, and during the summer months when glass factories are exceptionally hot, the operator very often neglects to regulate his burners. With the burner placed directly on the floor in connection with the side combustion chamber, it is then within handy reach of the operator, and for this reason he will make changes when they are necessary.

As shown in Curve A, Figure 1, there is a decided drop in the temperature of some lehrs at the end of the muffle chamber. Figure 4 shows a longitudinal cross section of the lehr. This drop in temperature has been overcome by extending the floor of the flues to the stack just a little beyond the stack. This stops air currents, and prevents a sudden drop at the back of the muffle chamber.

By the use of the slide dampers in the uptake side muffles, shown in Figure 2, the operator may throw his heat to the front or back of the muffle chamber, as he desires. This is a decided improvement over the old method of construction.

A great deal of trouble has been experienced in the use of muffle lehrs, due to the flue tiles cracking and allowing the products of combustion to escape into the lehr chamber. This is due to the intense heat to which the tile are subjected because the bottom of the tile is much hotter than the top, and because of this, the uneven expansion breaks the tile.

In Figure 4, you will notice the construction, the muffles of this lehr are made up of four sections. This construction allows for uneven expansion or contraction and will prevent breakage.

The crown of the lehr is an arch, placed above the muffle flues. This space allows the fire clay or fire brick to expand or contract without causing trouble. The muffle flues are free to rise or fall without disturbing the fire brick crown. The skew-backs have been designed so that the thrust of the muffle arch is absorbed without any strain on the side muffles.

Sometimes the glass manufacturer would obtain better annealing if he would consider other conditions outside of the lehr. Atmospheric conditions have a decided effect upon the results of annealing. Sometimes this is due to an insufficiently high stack, its location in relation to the factory roofs, or high hills in the near neighborhood, will at times cause the air to blow directly down the stack. Stack ventilators will stop reverse drafts. No doubt, you have known cases where the direction of the wind caused the ware to come off the lehr too hot to handle. Under the latter condition, better annealing can be done than if the ware comes off cold.

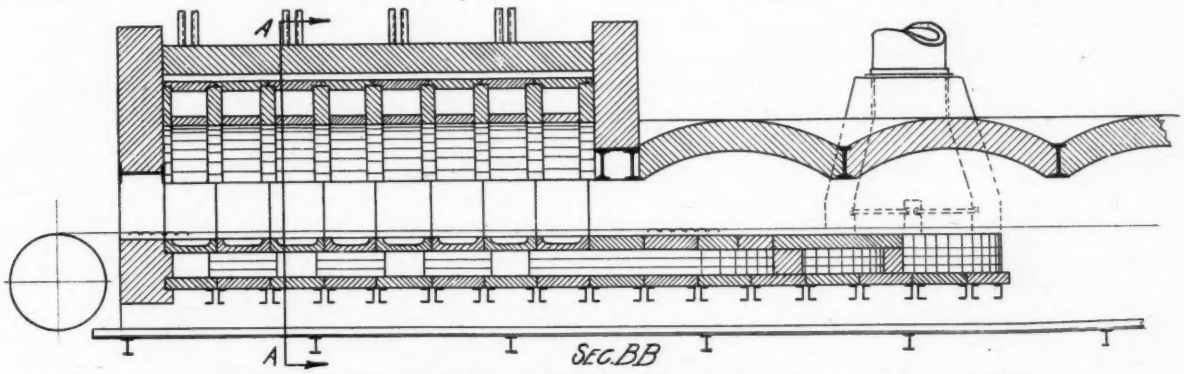

FIG. 4. SHOWING THE CONSTRUCTION OF MUFFLES OF A LEHR MADE UP OF FOUR SECTIONS.

One point that a large per cent of manufacturers overlook is the composition of the glass. They think they know just what the composition is because they have used the same batch for a large number of years. They forget they could use the same batch for ten years, and one bad car of raw material could unbalance the glass. Poor mixing of the batch is bad from many practical points, but especially from the point of breakage and annealing. In considering annealing problems, it is best to make sure the glass is well balanced. An intelligent revision of the batch along these lines can be made at a very moderate cost per ton. The reduction in breakage and improvement in the glass products will pay the cost many times over.

A reliable glass chemist should be consulted before revising the batch. The chemist should be one who knows and understands glasses. A uniformly good product should result.

It has been proven that proper adjustments of annealing conditions demand the use of reliable pyrometers. It has been demonstrated beyond question that a very liberal use of pyrometers is one of the very best investments that can be made. The very greatest improvement in glass lies in more perfect annealing.

Hints to the Chemist in Tank Glass Manufacture

By IRVING E. ADAMS,[1] S. B.

(*Written for* THE GLASS INDUSTRY)

THE rapid strides made in recent years in this country in the production, on a commercial scale, of optical glass, chemical glassware, heat resisting glass, illuminating goods, automobile lenses, etc.—progress made possible largely by a knowledge of the chemical and physical properties of glass, and attained through the mediumship of research laboratories, leads one to inquire if these agencies might be successfully utilized in the production of the more common kinds of glass: the soda-lime tank products, also sheet and plate, which constitute the great bulk of all glass produced.

As a matter of fact, some manufacturers in this field have utilized chemical ability to good advantage; others have established laboratories with indifferent success, while many have met competitive conditions and made money without technical aid. The application to this field is distinguished by the fact that the development of new glasses is not, as a rule, the usual objective, but rather stablizing existing processes, and introducing efficiencies tending to increase production and lower costs. I hope in this article to indicate some ways in which the chemist can make his influence felt in a vital way to the manufacturer.

The establishment of an analytical laboratory must be regarded as a means to an end. It will yield some information of value to the manufacturer, and it gives the chemist a tangible basis to start on. It will usually prove, however, that the analytical data supplied by the laboratory is not of paramount importance; that the raw materials are quite often of the requisite purity; that the manufacturer can rely with some assurance on the integrity of the jobber. The chemist will soon realize the futility of analyzing each shipment of sand or soda ash, and limit the control work to a necessary minimum.

In an old established concern, which has never utilized technical aid in the past, the employing of a chemist is an experiment. The manufacturer is cognizant of the application of modern science to various lines of industry and is curious to know whether these principles if introduced in his business, might be beneficial. He does not know how the chemist can best serve him, and so cannot intelligently direct his activities. He usually turns him loose in the plant, and permits him to work out his own salvation. Eventually, however, his work will be scrutinized and his achievements weighed. To justify the department, the firm must finally make better glass for the same cost, or as good glass for less money.

The manner in which the chemist can make his influence most quickly and effectively felt, will naturally vary in each individual case. There may be a very pronounced weakness that can be quickly remedied. Usually, however, a systematic study is preferable. The raw materials should be carefully analyzed; the mixing room subjected to observation as to condition of scales and efficiency of mixing machinery; the gas producers may be laboring with inferior coal, with incorrect blast conditions or with thin hot fires and irregular fills; there may not obtain the correct relationships between gas producer grate area, furnace design, and chimney draught; some point in the flue system may be unduly restricted; the regenerators are perhaps improperly proportioned or too closely stacked; the temperature control of the tanks may be neglected; too much or too little cullet may be employed; or the lehrs may be antiquated or of limited capacity.

The field of endeavor is limitless. A gas analysis outfit, a portable pyrometer, and a copy of Richards' "Metallurgical Calculations" will prove invaluable adjuncts to the laboratory equipment.

The chemist will probably, at some later period, ask for an experimental furnace to enable him to make melts on a small scale. As a general rule, this will not prove economically worth while. To be of real value, experimental results must be capable of duplication on a commercial scale, and, in this instance, results obtained on a charge of a pound or two, bear no relationship to what one might expect in a tank of many tons capacity.

The best way to experiment, hazardous as it may seem, is with the tank itself. It is, of course, essential that the experimenting be conducted with the greatest caution and that no change be made that would jeopardize production. But by limiting endeavor to a single small change over a proper interval, much accurate information will be gradually accumulated.

For those chemists who have progressed far enough to be entrusted with the actual making of the glass, some general observations resulting from several years of experience in soda-lime tank practice may prove of interest.

There is a best batch for your particular operating conditions. The choice and proportions of raw materials will be influenced by the "pull" on the tank, the temperature attainable in the melting zone, and the character and amount of cullet available. The batch must be sufficiently fusible to "plane up" properly under existing furnacing conditions and of the right physical characteristics to insure maximum speed on the machines and minimum lehr breakage. When the batch is finally adjusted, do not permit changes to suit the whim of any one.

Let us assume, as a concrete illustration, that machine-pressed flint ware is to be made on small tanks that are being "pulled" hard. Select as pure a sand as practicable—e. g., of a quality equal to that furnished to the glass trade from the well-known Illinois fields. To 1,500 pounds of this sand, use 580 to 600 pounds of 58 per cent dense soda ash, and not more than 150 pounds of burnt lime. Use all the cullet possible consistent with maintaining the color regular, up to a maximum of four pounds to five pounds of batch. Regulate the working end temperature by the machine requirements. Keep the melting end as hot as possible. If you are decolorizing with selenium, keep the tanks nearly up to temperature over Sunday to aid in "planing up."

[1] Superintendent, Federal Glass Company.

If your tanks happen to have excess melting capacity, so that you are not melting a ton of glass under twelve square feet of melting-end surface, you can probably reduce the soda-ash to 560 pounds, substitute raw lime stone for the burnt lime and materially reduce the amount of cullet used. Incidentally, this will make a stronger glass, it will be easier to maintain color,[2] and the production will not be affected.

In either case, at least 5 pounds of dense arsenious oxide is absolutely necessary as a batch ingredient, and a small amount of borax will aid in cleaning up scum in the melting end. The writer prefers to use powdered selenium as a decolorizing agent. My practice is to rotate a mixture of selenium, cobalt oxide, arsenious oxide, and powdered limestone in a drum, and have available a similar mixture containing no cobalt oxide. Whenever tank conditions require an increase in amount of decolorizer over that containing the right amount of blue, the addition is made from the second mix. The color of the glass is regulated by variation, from day to day, of the amount of decolorizer mix added to each batch. Since the amount of mixed decolorizer added daily does not provide sufficient arsenious oxide, enough extra is added as such to bring the total per batch up to 5 pounds. Contrary to the practice of many chemists, I prefer cobalt oxide to powdered blue.

A word in regard to lime. The question of using limestone or burnt lime hinges mainly on available melting capacity. Almost every argument favors the use of limestone, excepting the single one of ability to "plane up" the glass in big volume production.

The initial cost is lower, and the variations in composition of the burnt product, resulting from improper burning or deterioration in transit and storage, are not encountered. On the other hand, the decomposition of the calcium carbonate in the tank is an endothermic reaction, and while the total fuel consumption does not seem to be materially increased, it creates a cooler zone where the elimination of gas bubbles should be proceeding most rapidly, and shortens the refining period. Further, the type of seed remaining in the glass is objectionable owing to its size.

As to whether a high calcium lime is to be preferred to one of high magnesia content, is a question that has been much discussed. Without attempting, at this time, to recapitulate the various arguments, I will merely state, that, within the range of my own experience, most consistently satisfactory results have been obtained when using the high magnesia limes derived from the northern Ohio dolomites.

Lime gives strength to glass. It should always be used up to the maximum permissible in the class of ware made. For pressed ware, as stated above, the limit is very close to 150 pounds to 1,500 pounds of sand. Above this point chippage, machine strains, and annealing cracks will become excessive as a result of the shortening of the plastic range. In polished plate, where great strength is necessary, the customary batch contains 525 pounds of limestone, or 300 pounds of burnt lime, to 1,500 pounds of sand. Bottle batches contain high and varying amounts depending on the particular operation.

Tank operation, being a continuous process, demands uniform conditions. With a correctly proportioned batch, well mixed, made up of materials of unvarying purity, with no variation in character or amount of cullet, with the same melting-end temperature and the same "pull" on the tank, the glass will always be good. When the glass "goes bad" some condition has been violated and the chemist, with the resources at his command, should be able to render the factory superintendent invaluable aid in locating the trouble. Further, in forming a judgment as to the amount of decolorizer to add from day to day, the chemist should be guided by these conditions in conjunction with the evidence obtained from "proofs."

It is especially desirable that the chemist work in close harmony with the factory superintendent. Without the cooperation of this executive his troubles will be many. He must recognize at the outset that this man understands thoroughly the history, construction, operation, and idosyncrasies of the tanks in his charge. Long acquaintance has taught him the proper way to regulate stack draft and intake air to achieve the best working conditions, and the chemist must have indisputable proof that fuel consumption is unduly high, or combustion conditions imperfect before he suggests changes.

Probably in a vague sort of way, the manufacturer has this very matter of cooperation in mind when he employs the chemist. He knows where his practical man is weakest and is confident that many of his explanations as to why the glass frequently runs "off color" or "seedy" have no rational basis in fact. He hopes that the chemist, with his fund of technical knowledge, will help remedy this condition with resultant improvement in operating conditions. So, in closing, I can only reiterate that the chemist to be successful in this field, must be more than an analyst or engineer—he must be a diplomat as well.

[2] EDITOR'S NOTE: This a matter of opinion. One of the large United States manufacturers quite recently has returned to use of burnt lime, on account of a better color in blown flint ware.

Less Soda Ash Made Last Year

The domestic production of sodium carbonate in the form of soda ash was greatly curtailed in 1919. The sales amounted to only 981,354 tons, valued at $29,824,245, as compared with 1,390,628 tons, valued at $35,635.520, in 1918, according to R. C. Wells, of the United States Geological Survey, Department of the Interior.

The decreased demand in 1919 was well reflected in the price of soda ash quoted in the New York market. The year began with a sharp decline to $1.40 a hundred pounds for carload lots, the lowest price quoted for at least three years, from which there was a slow and steady rise, followed in 1920 by a heavy decline.

Soda ash is one of the cheapest and most widely used chemicals manufactured. It is used in making glass, soap, paper, caustic soda, chemicals, drugs, paints, leather, enamel ware, and cleansing compounds. Most of it is made from common salt, but a small quantity is obtained directly from the water of Owens Lake, in southeastern California.

The exports of soda ash in 1919 amounted to 50,481 short tons, valued at $2,656,608. This material was shipped principally to Canada, Brazil, Sweden, Mexico and Australia, named in order of decrease in quantity exported. The imports amounted to only 415 short tons, valued at $12,998.

How Glass Factory Mold Castings Are Made[1]

An Interesting Account of the Process, by a Practical Foundryman.

THE molds in which glass is blown or pressed call for the highest type of skill and patience on the part of the machinist who finishes them. All the larger glass factories maintain their own mold finishing shops and in addition to these, many shops in the principal glassmaking centers are devoted to this class of work exclusively. Their work is by no means confined to the shops in their immediate vicinity but as in the case of some of the famous American machines for which the molds are intended, their orders come from every country in the world where glassmaking machinery is used.

The creative spirit which brought some of these almost human machines into existence and the high degree of skill necessary to finish the molds seem to have stopped at the door of the machine shop. At present there are no foundries devoted especially to the production of iron castings for glass house molds. Such castings generally are made in some jobbing shop in the vicinity of the machine shop which has the order for supplying molds. It is well known that every jobbing foundry has its own standard mixtures which are as nearly the same and as few as possible to cover a given range of work. An inquiry conducted recently by *The Foundry* revealed that there is no unanimity of opinion among the different foundries producing molds in which glass is to be blown or pressed. Any jobbing gray iron foundry is willing to take on an order for some of this work and then pour the castings, as one foundryman expressed it, "from our regular mixture." This regular mixture varied from a metal having a silicon content of 2.50 per cent in a light machinery shop to one running less than 1 per cent in a plow shop, which would produce widely differing metals.

Many different materials have been tried in the manufacture of glass factory molds, but none of them equals cast iron. The ideal mold must be hard enough to take a high polish and to resist the constant scouring necessary to keep it in good working condition; and still be soft enough to permit the machinist to tool and finish the face at a reasonable cost. The same condition prevails to a certain extent in the manufacture of molds for rubber tires and the same measures practically are observed to attain the desired results. The face of the mold in both cases is poured against a chill and in some cases where the amount of glass factory work on the floor seemed to warrant, special charges have been made up to pour it. At least one foundry claims to get superior molds from a semisteel mixture while another which does a considerable amount of this kind of work uses charcoal pig iron in the mixture.

The superintendent of one glass factory frankly stated that he was disappointed in the quality of most of the molds received. This factory maintains its own finishing shop, but as in the case of other factories places its orders for castings with any shop that is willing to take them. He pointed out that in many cases this is an absolute necessity because frequently they receive orders for glass goods which must be delivered on a certain date or the order forfeited. It then is a case of getting the mold castings in the shortest possible time and the foundry which promises the quickest delivery gets the order. He said that it is not a question of cost either with his company or any other with which he is acquainted, they are perfectly willing to pay a premium to secure satisfactory molds; but so far have been unable to do so.

For various reasons none of the glass manufacturing companies, as yet, has seen fit to operate its own foundry, but at the present time one of the largest is seriously contemplating the erection of a small foundry in which to carry on a series of experiments to determine just what is the most satisfactory iron for glass bottle molds. The molds are subjected to many severe tests and it is only natural to suppose that a special

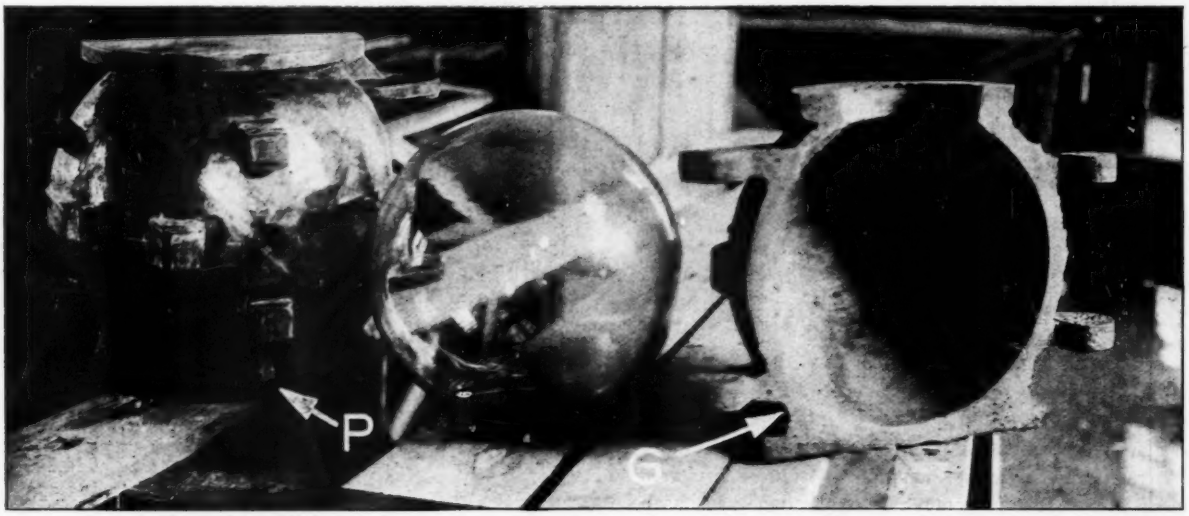

FIG. 1. THE PATTERN ON THE LEFT AND HALF MOLD CASTING ON THE RIGHT FOR MAKING THE GLOBE IN THE CENTER.

[1]From "How Glass Factory Molds Are Made," by P. Dwyer, in *The Foundry*, August 1, 1920.

iron developed to meet these conditions would be a dividend paying investment.

When in use glass molds are kept as nearly as possible at a uniform heat temperature of 300 degrees Fahr. If they are used while at a lower temperature fish scales or blisters are formed on the surface of the bottle, while if they become much hotter the molten glass adheres to the fac of the mold. The molds are swabbed lightly with crude oil at frequent intervals. The frequency of this treatment varies according to the size of the bottle, but in general it may be said that one application of oil is sufficient for the blowing of from 20 to 30 bottles. The oil seems to perform the same function in the iron molds that coal dust does in a sand mold for an iron casting. It makes the face of the mold smooth and shiny.

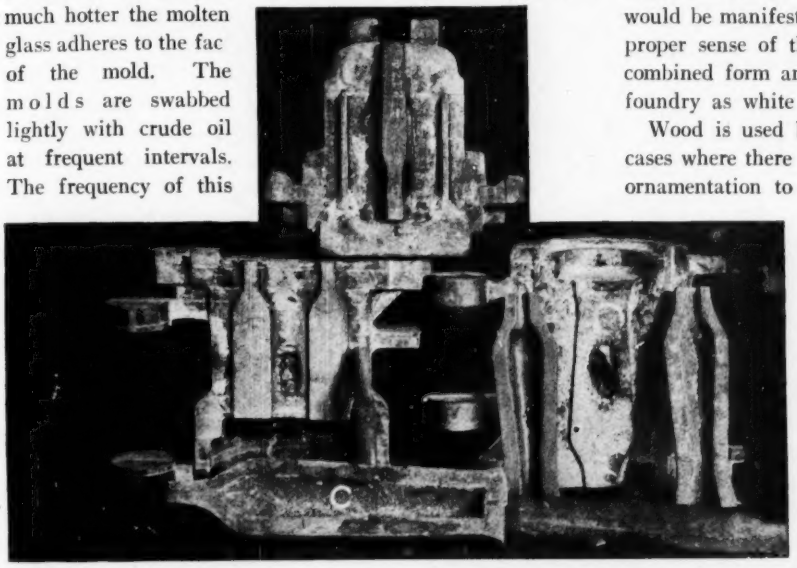

FIG. 3—TYPICAL WOODEN PATTERNS FOR MAKING SINGLE AND DOUBLE BOTTLE MOLDS, ALSO CHILLS FOR SAME AND WOODEN PATTERNS FOR MAKING CHILLS

Typical patterns together with the chills used for making bottle molds are shown in Fig. 3. A close up view of one of the molds is shown in Fig. 2, in which it will be noted that the casting is all in the cope. The molds on this particular floor are made on a pneumatic jolt-squeezer but in many shops they are rammed by hand either on a bench or on the floor. In the mold shown in the illustration, the cope part of the flask is set on the machine first, filled with sand and jolted. It then is turned over, the drag set on, filled with sand and squeezed. The drag is lifted off first and placed on the floor, then the pattern is drawn out of the cope, after which the riser and gate are reamed out. The core *A*, Fig. 2, to form the recess at the bottom, and the chills *B* then are placed in the drag, after which the mold is closed. The chills in some shops are oiled, but the popular practice is to give them a light coat of blackwash and dry them in the oven before using.

The smaller chills like those shown in Fig. 2 are solid; but large ones as illustrated at *C* in Fig. 3 are lightened on the lower side. The term chill as applied to these devices is rather misleading inasmuch as they are not expected to chill the face of the casting. The entire interior face of these molds has to be machined all over, a process of course which would be manifestly impossible if the iron was chilled in the proper sense of the word, that is if the carbon was in the combined form and the iron in the condition known in the foundry as white iron.

Wood is used both for patterns and coreboxes, except in cases where there is a great deal of intricate detail work and ornamentation to be reproduced. Plaster of paris is substituted in such instances. The latter is a particularly convenient medium for securing reproductions from sample pieces submitted as patterns. In many cases it solves the problem of making intricate coreboxes and maintaining an even thickness of metal throughtout the walls of the desired casting. In the pattern shown at *P*, Fig. 1, plaster has been used to increase the size of a wooden pattern from a 12 to a 14-inch size. At *G*, in the same figure, is shown one-half of a casting for making the mold in which the globe in the center is made.

In all pressed glass work and in the majority of blown glass objects there is a well defined seam or seams indicating

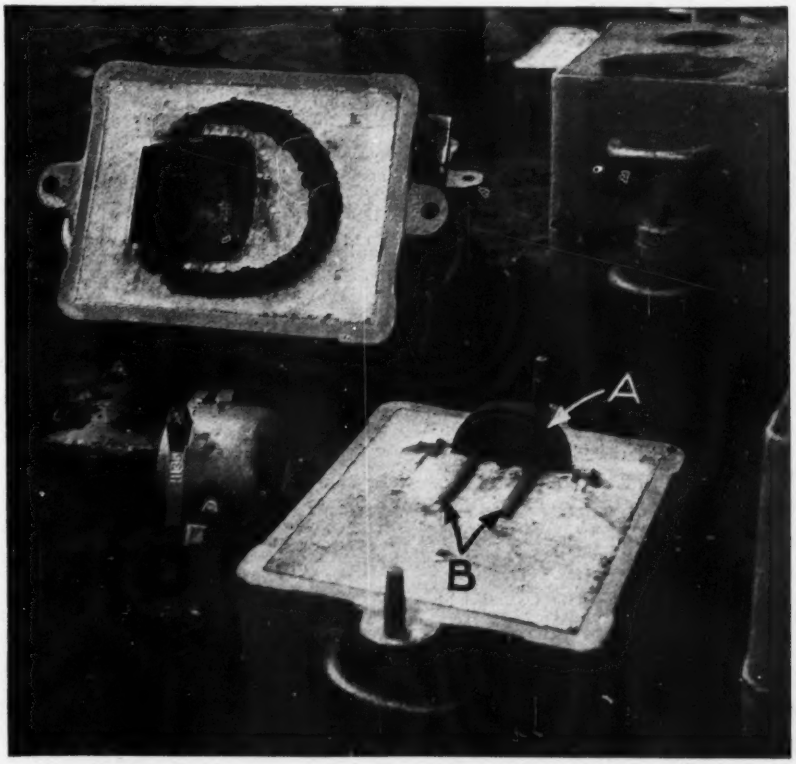

FIG. 2—MOLDS ARE CAST FACE DOWN WITH THE BODY OF THE CASTING IN THE COPE—THE MOLD SHOWN IS FOR A DOUBLE BOTTLE MOLD

the joints of the mold in which the object was made. In the globe shown in the illustration and all similar goods there is no seam or mark to indicate that they were blown in a jointed mold. The explanation lies in the manner in which the glass is manipulated while it is being blown. The mold is painted with oil and then dusted lightly with fine apple wood sawdust. While the blowing is going on, the blow pipe to which the glass is attached is slowly rotated to impart a horizontal motion to the globe. The sawdust acts as a buffer, cushion and lubricant, all combined and the result is a globe which does not show any sign of a mold joint. One application of oil and sawdust generally is sufficient for approximately 50 operations, after which a fresh coating is applied.

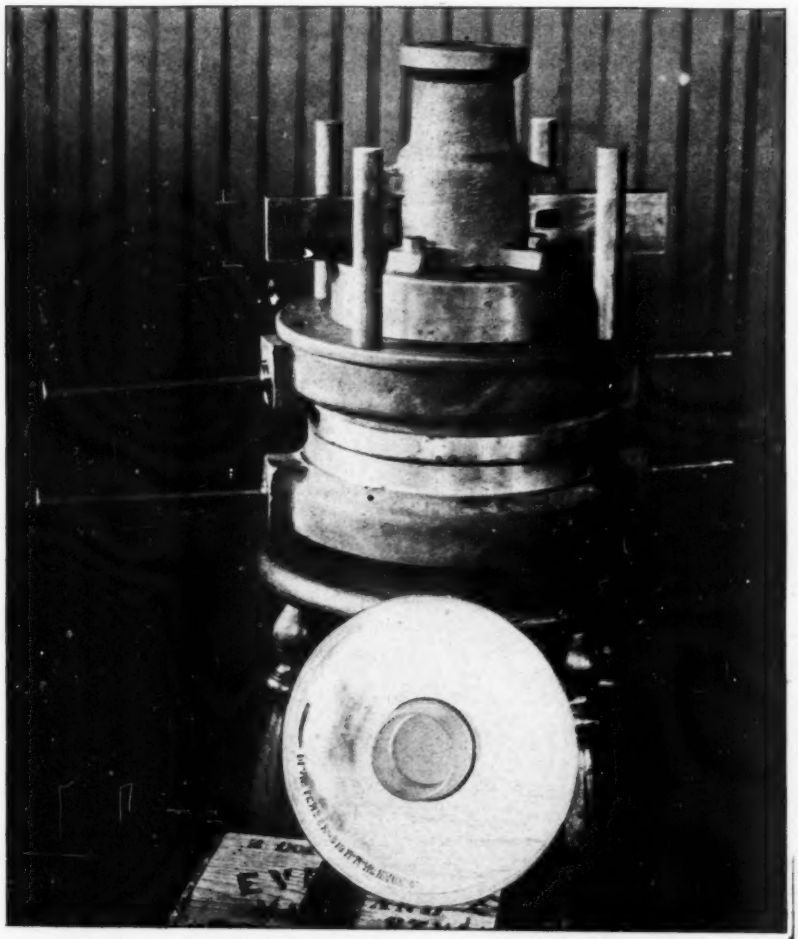

FIG. 4—AN ASSEMBLED MOLD FOR MAKING THE AUTOMOBILE HEADLIGHT WHICH IS SHOWN IN THE FOREGROUND

A curious characteristic of glass, particularly pressed glass, is that the quality and degree of finish on the face of the mold is directly reflected in the product. A mold made of hard close-grained iron having a smooth and highly finished surface will produce glass goods having a much better appearance than molds made of a softer grade of iron. Furthermore, since the molds have to be scoured at frequent intervals to remove the scale which forms as a result of using oil on the face, the molds made of a hard grade of iron will give much longer service than those made of a comparatively soft grade. The molds are held to close limits as to size and when these limits are exceeded the mold has to be scrapped irrespective of whether it is in good working condition or not.

Notes on Soda Ash

THE following grades of Soda Ash occur in commerce:

58% Ordinary and 58% Dense.
48% Ordinary and 48% Special.

The 58% ash is the highest grade manufactured, and contains about 99% sodium carbonate.

The only difference between 58% ordinary (or light) and 58% dense is one of density, the dense ash weighing approximately twice as much as the light ash, for the same volume. Chemically, there is no difference.

Ordinary 48% ash is made by adding common salt to 58% ash, until the sodium oxide content has been reduced to 48%.

Special 48% ash is made by adding sodium sulfate to 58% ash.

Before modern methods of manufacture were developed, soda ash was an impure product, and no 58% ash was available for production of glass on a large scale.

It was formerly often customary in the glass trade to use 48% ash. But it was early pointed out by manufacturers of pure soda ash that nothing was to be gained by adding salt to an already pure product. Salt is simply volatilized in a glass furnace. Today, except in occasional emergencies when unobtainable due to car shortages, the use of 58% ash by glass manufacturers is universal.

As it leaves the plant, soda ash is nearly always a very uniformly pure article containing the full 99% sodium carbonate. It is customary to load the dense ash into box cars while it is hot. All soda ash on exposure to atmosphere takes up water and carbon dioxide, forming sodium bicarbonate.

During ordinary shipment, only the outside layer undergoes any change, and as received by the glass manufacturer, soda ash is nearly always up to standard. It is in fact unusual to find any cause for complaint in the quality of dense ash ordinarily furnished.

If the storage bins are tight, and soda ash is used with regularity and not kept unduly long in storage, it will rarely contain over 2% of sodium bicarbonate. This is relatively a small percentage decrease of total sodium oxide content, and unless unusual storage conditions are encountered, the glass maker need have little fear that his soda has "lost strength." In rare instances in which the light grade is used special care must be taken in handling it.

Filtering and Purifying Glass Pot Clays

The Filtration of Colloids[1]

DR. W. R. ORMANDY, lecturing the Chemical Engineering Group of the Society of Chemical Industry on this subject, on July 13, on the occasion of the annual general meeting, held at Newcastle-on-Tyne, gave an account of the work that is being done in this country [England] to develop the principle of the electrical separation of solids, or osmosis, which is the term applied to it. The original work is due to Count Schwerin in Germany, and was begun before the war. Up to that time the process found little favor in this country, but during the war it was developed in connection with the purification of clays for the manufacture of crucibles used in glass-making. Since then it has been placed on a commercial basis by the Osmose Co., Ltd., which has both a purification machine and a filter working on this principle. The latter, however, has not received the attention bestowed on the former. Taking a suspension of china clay, to which has been added a prescribed amount of alkaline electrolyte, and pouring it into a copper cylinder having a carbon pole suspended in the center, Dr. Ormandy showed that on passing a current of about 60 volts through the liquid so that the central carbon pole is the anode, the clay is not only deposited very rapidly on the anode, but, although the clay is deposited under water, nevertheless the clay on the anode will be found to be remarkably dry. This result is due to the peculiar action by which water is repelled from the anode through a porous diaphragm, the action being known as electro-endosmosis. It must be clear that if instead of using a stationary anode we use a horizontal rotating anode this process can be made continuous, and a working model of such a continuous plant was shown. The anode is a rotating drum made of a special alloy to resist the corrosive action, whereas the cathode consists of copper strips placed round the anode, and distanced about ¼ in. therefrom. The bottom of the containing vessel contains paddles to keep the clay in suspension. The clay suspension consists of clay particles having a comparatively strong negative charge and other bodies having a very feeble negative or no charge at all. In the electric field between the cathode and the anode the clay particles are strongly attracted to the anode. The moment a film of clay has been formed on the anode the water contained therein is violently ejected towards the cathode, and this stream of water tends to sweep away all but the particles having a high negative charge, which, in spite of the water current, are drawn to the anode. The machine acts not only as a means of collecting clay from the water suspension, but is a selective collector, and simultaneously acts to a considerable extent as a drying machine. Although such a process cannot be considered as an ordinary filtration process, nevertheless it is, *inter alia*, a process for the continuous separation of suspended matter from suspending liquid with simultaneous partial drying of the solid product. Obviously such a continuous process can only be employed where large quantities of material have to be handled, but the same principle is embodied in the Osmose filter press, which consists of an ordinary type of press made of insulating material, the filter cloths being placed upon insulated pieces of conducting material, such as wire gauze or the like. Into such a chamber the clay suspension can be passed under just sufficient pressure to ensure that the chamber keeps filled. Without the application of electricity under these conditions there will be no filtration, for the filter cloths would be choked from the first moment. By the application of a potential of 60 volts, however, the water is forced out through the cathode, and a firm, hard cake results very rapidly, and even in the case of plastic ball clay a 3-in. block can be made in an hour containing less than 30 per cent of water. It would be impossible to produce a 3-in. block of ball clay in an ordinary filter press with 200 lb. per sq. in. in days, let alone hours. The essential difference between the Osmose machine and the Osmose filter press lies not only in the continuous action of the Osmose machine, but in the fact that the machine brings about a certain selective purification or separation, whereas the filter press by its nature merely serves to collect the whole of the suspended product.

[1] From the *Pottery Gazette and Glass Trade Review.*

Cleaning Mirrors

Question.—There have come to my shop some old mirrors stained so badly that it is almost impossible to clean them by means of either nitric or hydrochloric acid, used even chemically pure. This happens especially with mirrors that have been made by the quicksilver or mercury process and then backed with tinfoil. It seems that after several years this amalgam holds so hard to the plate glass that it is impossible to get it entirely off by scraping or the use of the above-mentioned acids. Sometimes I have a very rough surface, something like a scale, on the plate. I do not know if the glass has been attacked by the quicksilver, or if it is only a matter of cleaning.

Answer.—As mercury is soluble in nitric acid, it would seem to us that if you prepared a solution of equal parts of nitric acid and water, by measure, and then heat the acid, say, to about 160° Fahr., and the glass to nearly the same temperature, and apply to the side that has been coated with the mercury amalgam, it should entirely remove the mercury and any oxide that may have formed during the process of years.

After cleansing as outlined, wash thoroughly in water and immerse in a strong solution of sodium syanide and water—

Sodium cyanide	6 to 8 ounces
Water	1 gallon

or apply the cyanide solution to the glass by the aid of a swab or small mop.

Other combinations that might be tried are:

Hydrochloric acid	12 ounces
Nitric acid	4 ounces
Water	1 gallon

Temperature as outlined, or you can also try

Hydrofluoric acid	8 ounces
Water	1 gallon

This combination should be tried out if the cyanide solution does not remove the brownish oxide.—C. H. P. in *The Metal Industry.*

The Glass Industry

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NEW YORK, NOVEMBER, 1920

THE GLASS INDUSTRY

The purposes, principles and policies underlying the publication of THE GLASS INDUSTRY have become quite well known through the prospectus already distributed generally throughout the trade so that in introducing this, the initial number of the new journal, it hardly seems necessary to refer otherwise than briefly to the circumstances which led up to the inception and execution of the plans that have now materialized in the form set before our readers.

Establishing a paper of this kind is of course primarily a business enterprise; founded upon any other basis it would almost inevitably come to grief. But in this case the hope of gain was not the only allurement. Other influences had their effect, among which was the fact that the situation resulting from the lack of a technical trade journal in the glass field, presented, from a publisher's standpoint, an unusual opportunity for establishing a technical paper, not as is sometimes necessary, after cut-and-dried plans, in accordance with a pattern already established by existing publications, but along ideal modern lines. Not only was the situation ripe for the founding of such a paper; it was, in a sense, imperatively demanding one, so much so as to constitute almost a challenge to any publisher who appreciates what a good trade journal means to an industry, to avoid the task if he dared to!

Our great glass industry is really just beginning to shake off the shackles of antiquated methods and is entering upon a period of progress destined, according to the belief of many of its foremost representatives, to witness the most remarkable and extensive developments in its history.

Speaking before the American Ceramic Society last year, Dr. Edward W. Washburn said:

"Although one of the most ancient of the chemical industries, the manufacture of glass, like most of the other ceramic industries, has been one of the last to feel the influence of modern science. This is, of course, due largely to the fact that the industry, being older than the science, had necessarily to develop along purely empirical lines. The rule-of-thumb methods, and their accompanying 'trade secrets,' which characterize the development of a complex industry by this method naturally bred a conservatism of viewpoint which did not easily appreciate the value of scientific research or the advantages of scientific control over the materials and the processes of the industry. . . . But in glass making we know *how* today much better than we know *why*. Progress demands that we know why. No industry which merely knows *how* is in a healthy condition. The feeling of confidence which comes with knowing the why of every step in the manufacturing process carries with it certainty of control, progressive lowering of costs, enhanced protection of the workmen, progress in the development of new and improved products and a degree of insurance against such evils as might otherwise attend the exhaustion or temporary scarcity of certain raw materials, fuels, machinery or other necessary supplies."

Every day progress is made, new ideas worked out, improved methods developed by some one, somewhere, but how little is generally known about them! How few learn of them and how small the benefit derived by the industry as a whole compared with what might be if the results were better known and more widely utilized.

Manufacturers are beginning to appreciate the necessity for scientific methods of control of all glass making processes, a necessity that is compelling all who would avoid falling behind in the march of progress and who desire to prepare themselves to weather the rough seas of hard competition that must inevitably be traversed sooner or later, to be continually revising their ideas, looking for and learning newer and better ways of doing things and adapting their plants and organizations to them.

Many realize this, in fact throughout the industry there is developing an alertness to learn, an eagerness to *know* instead of *guess*. But where can the seeker after knowledge find the facts he wants? Except in the splendid publications of the scientific societies, the Journals of the American Ceramic Society and the Society of Glass Technology, practically no attempt has been made to obtain and publish regularly, original papers, discussions and data on glass manufacturing.

It is the aim of THE GLASS INDUSTRY to remedy this deficiency and the cordial responsiveness of practically all who have become acquainted with our plans and purposes convinces us that we have a favorable opportunity and shall be able to build up a publication that will be of positive value to the industry, one that the trade as well as the publishers will be proud of.

The speed we shall make in developing the paper editorially will, of course, depend largely upon the co-operation accorded by those who are qualified to contribute papers and other data relating to glass research, technical and manufacturing problems. The broad-minded attitude already manifested on this point by many leading glass men relieves us, however, of any anxiety as to the responsiveness of the progressive element of the industry.

Technical Consultation Service

EDITOR'S NOTE: The Glass Industry purposes to maintain a department devoted to Technical Consultation Service, to which can be referred not only general questions pertaining to the manufacture of glass, but also personal inquiries covering specific problems constantly arising in factory practice.

Glass men who were consulted, particularly the smaller manufacturers, agreed that the need for practical technical advice is fast being realized, but that in the minds of many men directly responsible for manufacturing processes, there exists no definite idea as to just what so-called scientific work in glass manufacture embraces, or how to go about securing competent advice.

How useful and valuable the consultation service of a publication may be, is well illustrated by the case of a well-known metallurgical paper which has successfully maintained a technical service department for many years. Through its columns nearly 3,000 queries have been answered and it is a remarkable fact that these inquiries were received not only from practical shop men and foremen, but also from superintendents, engineers, chemists and other highly responsible executives, many of them connected with very large and prominent manufacturing concerns. It often happens that what is common-place knowledge to one man is just what another needs to know when new tasks confront him or old methods fail to satisfy. Even the most competent and experienced chemist or engineer, especially when working along new lines, finds an opportunity of consulting others and checking his own results with theirs almost invaluable.

To establish a technical service department in the new glass publication seemed a peculiarly difficult undertaking—glass men themselves can readily understand why. However, the department is here.

After our readers have gone over the department editorials in this first issue, we hope all who so desire will use the service whenever they wish. Whether it is to give a method for chemical analysis, or to answer a question about quality of raw materials, or to help solve a vexing melting trouble, we stand ready to serve so far as we can.

Starting with the next issue, we expect to give each month one or two actual examples of how technical advice has been of direct benefit to glass manufacturers.

Can a Technical Consultation Service department in The Glass Industry be of value to

The Glass Manufacturer,

The General Manager of a Glass Factory,

The Glass Factory Superintendent, his foremen, fuel men, and chemists?

It can. But will it, and to what extent?

THE answers to these questions, as well as the success of this department, depends first upon the interest we can arouse in the men who really make glass, and then upon the continued confidence they place in replies received to their questions. It is axiomatic that confidence will be measured by satisfaction with explanations given, or by results obtained from suggested procedures.

In this first issue, therefore, it is aimed to outline a policy which will receive the attention, and it is hoped the approval also, of glass men who read it. We can, of course, only anticipate what queries are liable to be made, so if any reader desires service on glass problems not even remotely mentioned herein, it is our wish that he submit his inquiry. So far as expert opinion is available to us, all subjects pertaining to glass will be diligently considered.

Outside of the fortunate few who have proved and true technical men in their own factories, or who know where to refer their questions, every manager has frequently wished he might find out why, with the same materials used in the same way, melting troubles come and go. The first thing that comes to mind usually is a question as to whether raw materials are up to standard, although most glass-makers now realize that furnace control is just as important as constant composition in batch.

More than once during the past year most factories have experienced shortages in supplies. Given a chance to augment the usual materials with some from a different source, does the busy manager, or his purchasing agent, know where to turn for a quick answer so that prompt decision can be made and orders placed for good material, and poor supplies be avoided?

Some limestones and burnt limes introduce more iron into the glass batch than does sand. The iron content of sand can be judged to some extent by color, but iron in lime cannot. A flint glass manufacturer is careful of the quality of his sand, but does he have his lime examined periodically for this green color-imparting impurity?

How many readers know that there are methods applicable to factory practice by which the degree of annealing of glass, up to the practical point, can be determined very quickly after one has become familiar with the method? Or that there are instruments which, in the hands of trained men, give valuable aid in determining if cords and "wavy" glass have been caused by faulty furnace operation?

Temperature measurement for annealing is essential. Pyrometers for this purpose ought to be accurate, and most of them are, when installed. The accuracy should be maintained. Is it? Pyrometers applied to melting furnaces have their limitations, both for practical results obtained and for accuracy under maintained temperatures. This is particularly so in the melting ends of tank furnaces. But no furnace today ought to be without pyrometers. In what condition is the temperature measuring equipment in your factory? If you are not sure, how can you find out?

Remarkable results in prolonging the lives of glass furnaces are being secured by using air streams and water pans. Yet up-to-date water-cooling is comparatively rare. Every superintendent has tried it in some manner with steam jets, water jets, or contact plates over which water flows—often slopping the water down into the "cave." And some, not so long ago, have pronounced it of little value. But now the time has arrived when it is known that water-cooling is of great value, and if the owners do not already know it, the time is not far distant when they will realize that if it is not successful on their continuous tanks, money is being lost. Should coolers be unsatisfactory, the fault lies either in the method of application, or in the kind of water. Suppose it is the water that is suspected—say a water from the middle west, containing iron or lime, and which scales so quickly that coolers are rendered useless. Has the superintendent a competent chemist to whom he can refer the matter for a report, so that he can inform his employers what is necessary if they wish to use coolers?

Or perhaps the manager has been considering adding a scientific worker to his force. Where can he get a man? What should he pay? How much will it cost to install a laboratory? What results can he expect? Certain "trade secrets" or "wrinkles" have been worked out in the factory which are believed to give his factory the edge over competition in one particular field. Is it a good proposition to have a technical department acquainted with these matters?

It has happened that in times of baffling troubles a manager has had his glass analyzed. The analytical reports were received. But what did they mean? How are they to be interpreted in terms of getting rid of existing trouble? The analysis is all right, but what can it prove?

Then there are the questions of fuel analysis, producer regulation, combustion gases, flue and stack drafts, maintenance of color in glass, causes of seeds and even sometimes "reboil" in revolving pots—in short, we could go on naming everyday problems which are of dollars and cents importance to the glass manufacturer.

If we named in a general way all the problems which properly belong to a chemical-physical-fuel engineer hold-

ing a technical position in a glass house, we would be only paraphrasing what has been occasionally said and written before our time. The point is, if the technical man *can* do these things in a glass house, why *isn't* he doing them? The answer is that in a few of our factories, real scientists have done and are daily doing fine work along these lines.

In an article such as this we would be making a mistake if we did not refer to what has already been accomplished in the glass industry in the United States. Of mechanical achievements there is no need for comment. The technical efforts have not been so spectacular, but some of the results have been remarkable. Laboratory and baking glass ware are only two examples.

The cooperation of trained scientists with the manufacturers to aid in developing optical glass, so sorely needed during the war, furnishes another example. Some of our largest companies have well organized staffs of experts permanently working on refractory and glass problems.

But the fact remains that technical aid is not employed by the rank and file of executives in the glass industry, and that some of our good-sized corporations have not made and do not make it a practice to refer problems to a technical department. The reason must be because the value of such action has never been demonstrated to them.

A progressive executive thinks ahead. But he is usually a busy man, and while in our industry he would like to know to what extent scientific workers in the glass field might be of service to him, the methods which would be employed to answer his questions are to him in the main intangible, and mental queries are soon replaced by the positive problems of supplies and production.

It is the purpose of this trade paper to have its Consultation Service act as a connecting link between the laboratory and factory practice. Where such relations already exist to a full extent, we are glad. We shall welcome articles, suggestions, and discussions from laboratories already established. In fact, criticism of our own views may not be amiss. However, if in an humble way we can occasionally help along both the executive and his technical department, our efforts will be worth while. Each time a rule-of-thumb method is made clear, or improved upon, by scientific facts, a forward step is made.

Chemistry (with the inseparable physics and engineering) as applied to glass house problems is a straight business proposition. There is no place in a live organization for the chemist who looks mysterious and has a lot of secrets. Just as an executive does not tell all he thinks and knows, neither does the chemist, but unless a manager has for the head of his technical department a clear thinker in terms of what is expended and what is produced, results are liable to be unsatisfactory. Such technically trained men, unless they be taken young enough and developed, are not to be had for less wages than a carpenter or brick layer. If young men new to the field are started in, added remuneration must be in keeping with their services and results; capable men cannot be held too long at meagre salaries.

While we expect, as THE GLASS INDUSTRY grows from a modest beginning, to be consulted by non-technical men, we believe that not the least valuable service we will give is going to be to the young chemists and engineers who, during the next five years, will enter the industry. The manufacture of glass is essentially a chemical process, and we believe is one of the ten largest chemical businesses in the country. Yet outside of the very few brilliant exceptions, the industry is managed by "practical" men. The very fact that these men have, by their own efforts largely, arrived at their positions augurs well for the future. For it is becoming known that knowledge about glass is making rapid strides. Just as research has developed the metallurgical industry, it is now entering the glass field. Our managers and superintendents now know "how." They also want to know "why." They are beginning to realize that knowing "why" gradually eliminates guesswork and its periodic troubles, and that knowing "why" means fewer worries and greater production.

We were interested, during a recent visit to one of the large steel corporations, in meeting a young chemist who had been, for the half-year since his graduation from college, daily working his shift on an open-hearth furnace. The analogy? When the large glass companies begin to select trained young men for a definite course of training, perhaps starting them at "filling in," they will find they can develop the kind of executives they will desire. Only one who has tried it can realize the difficulty of establishing a practical relation between a laboratory, and a furnace "bull." The relationship is there waiting to be found. Not every manager or superintendent desires the services of the technical man. Experience has shown us that when such is the case, it is prudent not to waste too much time in such a situation. Sometimes, in this event, the explanation is that for some reason the technical man has failed to put across directly his ultimate results.

It would seem an almost absurd assertion to state that chemistry and physics applied to glass manufacturing are panaceas for all troubles, yet it is true that more than once, sometimes as a last resort, a chemist has been called in consultation to solve a baffling difficulty. If he has been successful, the work was taken for granted. If he has failed, his profession has been classified in a certain way by the employer.

Many problems can be quickly solved by an experienced man; but others require much time and work. Unfortunately, it has happened that inexperienced consultants have attempted work in the glass field, and sometimes impractical advice has been given. Again, entirely honest workers have failed because they attempted too much. Any one of the problems mentioned at the beginning of this article would keep busy a man, new at the work, for weeks and months, even though he had a good basis of scientific training. If one man is to form a technical staff, he must limit his activities accordingly. If the factory is large, he cannot do accurate analytical work and factory work at the same time.

It should be made clear that in some cases the technical worker can come to a point quickly, and give "facts" and specific recommendations; in other cases, he can only give "opinions." Further, control work by analysis of raw materials is routine only; control is a function of a laboratory, but "research" is an equally important part.

Now, we hope you wonder just how these columns can be of real benefit, and in what manner it is proposed to handle its problems.

To begin with, we are in position to furnish methods of chemical analysis. A good analyst often is benefited by a practical method in use by another chemist.

If you haven't a laboratory, we can advise who is qualified to do your particular work. We can try to help in interpreting the results.

If you want to start your own laboratory, we can give you much valuable information when we know what you have in mind. We can save your new technical man or men much valuable time in showing them how to systematize their work, and keep data pertaining to glass.

Obviously, we cannot run an analytical consulting laboratory for our readers, though we are in touch with several in the field. We do hope, however, at a later date, to be able to answer certain questions covering physical aspects of glass samples submitted.

We can indicate how you can go about a solution for problems submitted. We can refer you to literature covering some fields. (Recently both American and English journals are publishing excellent articles on glass, and our own Government has issued some interesting publications.)

It is anticipated that often a manufacturer will hesitate to use our service for fear his problems, or their solution, will become known to his competitors. Whenever request is so made, "trade secrets" will be carefully kept, and replies will be personal answers in letter form.

Another point which should be made clear is that it would not be sound business for any company to allow all the information which it has on a certain subject to be made public. In consulting work, it is sometimes understood that the same kind of problem will not be worked on for a competitor. A good illustration is furnished by our reference near the beginning of this paper to certain instruments for physical testing of glass. The development of these is an outgrowth of work done at the Bureau of Standards, but it has taken an expensive technical staff to apply them to factory problems, and the results of this work are not common property. Any manufacturer wanting this information must necessarily work it out as applied to their own factories.

We want to repeat, however, that we hope there is some good to be derived from using our service. Once we worked for a man whose motto was: "Get all you can from the other fellow, but tell him nothing." It is our belief that this attitude is passing. What benefits an industry in general raises it to a higher plane.

If, as time passes, THE GLASS INDUSTRY can offer to its readers straightforward advice on technical matters, promoting discussion on general practice, but always careful of individual information, it is hoped to fill a place now vacant in the glass manufacturing field.—W. F. B.

CORRESPONDENCE AND DISCUSSION

While Cordially Inviting Reader's Criticisms, and Discussions and Expressions of Opinion on Matters Affecting the Trade, THE GLASS INDUSTRY Assumes No Responsibility for Statements Made in Communications Printed Under This Head

Priority Orders and Disorders

A Letter Setting Forth the Transportation Situation as Affecting the Silica Sand Industry.

October 16, 1920.

To the Editor of THE GLASS INDUSTRY:

Which came first, the chicken or the egg? If the chicken; was it black or white? If the egg; was it white or brown?

Having addressed one's self to the solution of these questions it may afford some degree of relaxation to consider whether the manufacturing and commercial enterprises of this country are superior or subordinate to the railroads and other forms of transportation and if a particular class of interest, farmers, miners, butchers or candlestick makers, has any right to priority in the use of such equipment and facilities as are available.

As to the chicken or the egg it is submitted that industry existed and thrived long before the advent of rapid transit. That with the scattering of our population and the establishment of settlements at distant points the need for a rapid and economical means of transport became acute. This need was met with the invention and development of the steam engine.

Transportation has never been, is not and never will be superior to the creative activities of this or any other nation. Irrespective of how primitive, industry would still exist if rapid transit were still unknown.

The shippers and receivers of freight pay every item of expense connected with the management and operation of the railroads, including the salaries of the executives and subordinate employees. Have not the shippers the right to look to these employees for the same degree of loyalty and endeavor that characterizes the efforts of officials and employees under their direct control? They look, but look in vain.

To revert to the beginning of the construction of the railroad highways: In conveying rights and privileges heretofore exercised by the government, Congress and the courts jealously and consistently protected the rights of the public by not invalidating in any way the obligations which attached to common carriers which theretofore had been applied to water and highway carriers.

DUTIES OF COMMON CARRIERS

Briefly stated, these obligations of the carrier were as follows: (1) To transport without discrimination the goods or persons of all who applied in the order of their application; (2) To transport safely with reasonable dispatch, and (3) To exact a just and reasonable compensation for their services.

In 1887, largely at the instance of the granger interests, Congress passed an act to regulate commerce, commonly known as the Interstate Commerce Act. Under the provisions of this act a commission was created having limited powers over certain phases of interstate commerce. This act has been amended from time to time and other acts have been passed, delegating power to the commission to perform certain functions with respect to railroad transportation, the most recent, the so-called Esch-Cummins bill, which became effective the early part of this year (1920).

Under the provisions of legislation which they are presumed to administer, the Interstate Commerce Commission (composed, by the way, of eleven members, no one of whom is skilled in railroad operation or management) is required to pass upon such matters as the issuance of securities, to establish a schedule of rates which will yield a return of 5½ or 6 per cent upon railroad investments, to enforce safety appliance acts, to inspect boilers and ash pans, to fix standard time zones, to remove unjust discrimination and, by the terms of the Esch-Cummins bill, to apportion cars.

During the war, certain abridgments of the common law obligations of carriers were made operative at the instance of the Railroad Administration, and these were in the main excused and sanctioned as "winning the war measures." Never before in any of the legislation, State or Federal, were the common law obligations of carriers in the least threatened. The carriers had always been held to a strict accountability for their failure to comply with these obligations by courts and commissions.

Under the provisions of the Esch-Cummins bill the Interstate Commerce Commission may, when in their opinion an emergency exists, suspend rules and regulations with respect to car service without regard to ownership, in an endeavor to overcome the emergency.

It is well to bear in mind that the exercise of this great power is contingent upon the "opinion" of eleven men, no one of whom is skilled in matters of railroad operation or management. Here let it be said that this is not an indictment of the Interstate Commerce Commission. The Commissioners are doing as well as they can what they have been directed by Congress to do. The fault lies in the law.

Prior to its passage, the Esch-Cummins bill in its entirety was considered at a meeting of the National Shippers Conference at Chicago by an assemblage of the traffic and legal representatives

of many of the prominent shipping concerns. At this time the consensus of opinion with regard to the car service section of this legislation was that the word "emergency" contemplated a port or terminal congestion or some local transportation blockade caused by strikes or other means which required immediate action in the detour or reconsignment of cars to avoid further complication. Never for a moment did its stanchest advocate presume that this cause would be seized upon by selfish interests to further their own ends. So much for the theory of the law.

SUSPENSION OF RULES DEMANDED

Shortly after the law became effective the railroads, but a short time before released from Federal control, through one of their committees headed by Mr. Daniel Willard, president of the Baltimore and Ohio Railroad, appeared before the Interstate Commerce Commission and represented: (a) a startling condition of degeneration in the matter of railroad labor, motive power and rolling stock and (b) a formidable array of figures representing coal tonnage that must be moved if a national coal famine were to be averted, entering a plea that, inasmuch as the railroads could not of themselves break the law without suffering the consequences, the Interstate Commerce Commission break the law by declaring an emergency to exist, requiring the suspension of certain car service rules and railroad obligations to the public.

As expected, in this plea the railroads were supported by certain coal interests, who painted a gloomy picture of the overshadowing fuel famine that threatened the nation. There was, however, a notable exception. Mr. G. H. Cushing, Director of the American Wholesale Coal Dealers Association, appeared before the Commission and vigorously opposed the issuance of priority orders on the ground that the bituminous coal production was already considerably ahead of the scheduled production for the year and that the action of the Commission in this matter would operate only to increase coal prices.

This statement, made months ago, he confirms in a public statement dated Oct. 14, saying that the figures for October 2 show that 545,000,000 tons will be mined or 10,000,000 tons in excess of his estimate of the national requirements. He further states that "priority orders" have meant nothing more than bad distribution. Lumber, shoes, grain and other markets have declined. COAL PRICES HAVE NOT. This is caused by the false shortage the people have been made believe exists.

This is injected here to show that there was a reasonable doubt as to the existence of a fuel famine. There seems to be no shortage of coal if one is inclined to pay the price. In this respect coal corresponds with bootleg whiskey.

Nearly coincident with the representation of the coal interests came the granger and financial interests urging the allocation of all box cars fit for the carrying of grain to that industry and as a result thousands of box cars were sent from the east to the west empty. The Commission may feel that its action in this matter has averted a national panic by enabling the farmer to convert his grain holding into cash and to take up his paper and relieve the pressure on the district banks.

In consequence of these representations the Interstate Commerce Commission issued their memorable "service orders," which in substance required the return of all open top cars to the mines "empty" and the movement of thousands of box cars from the east to the west "empty" to relieve a questionable coal shortage.

CARRIERS' OBLIGATIONS SUSPENDED

For the first time in our history, the common law obligation of carriers "to transport indifferently for all of those who applied in the order of their application" was set aside. Industries badly in need of equipment, industries on the verge of shut-down, were compelled to see thousands of cars go by their plants "empty" to the east and to the west, when these same cars could have been loaded and made to perform the function for which they were constructed.

With the relocation program that is getting the cars where they are needed, no fair minded shipper has any complaint. The theory that an empty car moves any more rapidly than a loaded one is fit only for the scrap heap.

Shortly after the issuance of the service orders a more pernicious practice was entered upon, namely, the issuance of special permits which permitted, for cause shown, the use of equipment contrary to the provisions of the service orders. For example, to load open top cars away from the direction of the mines. Space does not permit a portrayal of the conditions or the instances of discrimination that were cloaked with "special permits."

SILICA SAND INTERESTS PROTEST

Confronted with this situation, the silica sand shippers of northern Illinois reacted in the only manner they could, as did other industries. As long as the constituted agency had accepted the duty conferred upon them by Congress and were to relocate equipment and otherwise restrict the use of equipment, it was necessary that they have permanent representation in Washington to insist before the Commission and the American Railroad Association on the full observance of their rights.

They are committed to this policy (1) that available equipment must be apportioned among shippers pro rata according to their ability to load and ship; (2) that rolling stock in the service of shippers must be utilized for the purpose for which it was designed, a vehicle, and not a store house, and (3) that after a reasonable length of time has elapsed the equipment should be forced back into service by the imposition of severe penalties.

While in some measure in accord with the emergency provisions of the Esch-Cummins bill, they are opposed to the statute as it now reads and insist that the power should be exercised on something more than an opinion of the Commission; that this should be done only after full hearing and investigation at which the shippers should have the right to produce and cross examine witnesses to fully develop the existence of the "emergency" and the measures necessary to effect its relief. As the law now stands the miners and mine operators may indulge in wrangles with the attending strikes, in full confidence that their action will create an emergency and to relieve this emergency the Commission must give them prior consideration in the use of equipment. The opportunity for collusion is apparent and the law seems opposed to the dictates of common sense.

To accomplish an equitable distribution of equipment the silica sand interests advocate:

The repeal or amendment of any and all laws which restrict the common law obligations of the railroads.

The passage of a law requiring the Interstate Commerce Commission to conduct a national survey to establish the car requirements of the nation and, in connection with such survey, to establish a car rating to all industries and shippers that will reasonably reflect the ability of such industries and shippers to load and ship.

That the commission further be required to establish a uniform code of rules to govern the distribution of cars (1) as between railroads (2) as between districts on the same railroad and (3) as between shippers in the same district.

The abolition of all privileges and customs which have the effect of withholding cars from transportation service.

The establishment of a permanent Washington Bureau in the interest of the producers of crude or basic materials, which bureau shall urge the importance of such basic materials, oppose legislation inimical to the interests of the proprietors of such industries.

In the light of the developments of the last six months, it is imperative that crude material producers take immediate steps to save their business from annihilation. Facing a freight rate increase that exceeds in many cases the cost of a ton or more of their products, deprived of the vehicles which they ordinarily and customarily use in the transportation of their wares, the crude material shipper has been reduced to dire straits.

In conclusion, it may be repeated, the silica sand interests seek no advantage, they insist that cars sufficient to accommodate the

normal requirements of the nation should be acquired by the railroads and that in times of abnormal traffic demands this equipment should be distributed proportionately among shippers on ratings fairly reflecting the requirements of such shippers. Equality of opportunity is a constitutional guaranty and the only demand of the fair business man. Those who demand anything else should not be in the business. To this policy we are committed.

Washington, D. C.

R. E. RILEY,

TRAFFIC DIRECTOR:

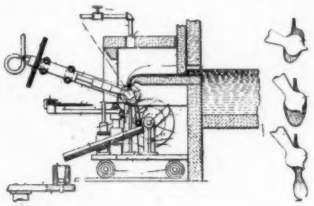
Ottawa Silica Co., United States Silica Co., National Silica Co., Wedron Silica Co., Ballou White Sand Co.

PATENTS

RECENT INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS FOR PRODUCING IT

Glass-Feeding Machine and Process. U. S. 1,349,551. August 10, 1920. Karl E. Peiler, of Hartford, Conn., assignor to Hartford-Fairmont Company, of Canajoharie, New York, a corporation of New York.

The object of the invention is to provide an efficient, simple and durable mechanism which will during predetermined intervals of time collect and shed uniform masses of the molten glass for subsequent shaping by molds, or by other means.

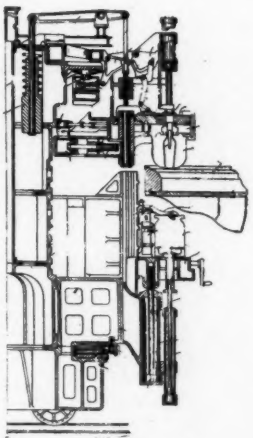


A rotatable gathering head is disposed beneath the discharge end of the fore-hearth or outlet of a furnace for collecting the desired masses of outflowing glass, and is periodically tilted to cause the masses to form in drops or gathers that may be readily severed and conducted away for further manipulation.

The machine, as shown in cut, comprises a container for molten glass having a discharge outlet, a bracket mounted to swing upon an axis substantially intersecting the flow of glass from the outlet, mechanism for oscillating the bracket, a rotatable gathering head carried by the bracket, and located substantially at the said intersection, and mechanism carried by said bracket for rotating said shaft and head.

Glass-Forming Machine. U. S. 1,348,365. August 3, 1920. Richard La France, of Toledo, Ohio, assignor to the Owens Bottle Machine Company, of Toledo, Ohio, a corporation of Ohio.

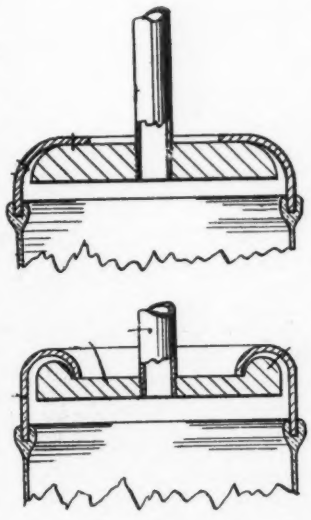
This invention relates to machines for forming bottles or other glass articles which are blown or otherwise formed in molds on the machine. An object of the invention is to provide an improved mechanism for holding bottles or other articles during the opening of the finishing molds and controlling said articles in their discharge from the molds. The invention as shown in accompanying cut is embodied in an automatic bottle blowing machine of the "Owens" type, particularly designed for making carboys or other bottles or containers of large capacity. Certain features of the invention are particularly adapted for use in connection with machines for making such ware.



This glass-forming machine consists of a carrier, an arm extending laterally therefrom for holding an article formed on the machine, a piston motor comprising an upwardly extending piston rod on which the carrier is mounted for movement lengthwise of the rod, said carrier having a limited up and down movement, a spring to hold the carrier in its upward position, a slot and pin connection between the piston rod and carrier, a cam arranged to rotate the piston rod during a portion of its downward stroke, and thereby rotate said carrier and arm to swing the arm laterally to a position over the article to be held, the piston being operable through said slot and pin connection to move the carrier downward against the tension of said spring during the final portion of the piston stroke and thereby move the arm downward to engage the said article.

Glass-Drawing Bait and Method of Using It. U. S. 1,349,200. August 10, 1920. Halbert K. Hitchcock, of Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Company, a corporation of Pennsylvania.

The invention relates to glass drawing baits as shown in accompanying cut and has for its principal objects: the provision of an improved bait from which the glass will not crack during the drawing operation; which is relatively cheap and durable; which may be employed to draw a full size cylinder without the usual reduced end and neck, thus saving time and giving a greater proportion of usable glass; and which does not require the skill in manipulation incident to baits requiring the formation of the reduced end and neck. Also the provision of an improved method of using the bait, whereby the preliminary heating incident to the use of the ordinary hot bait is avoided, as well as the necessity of cleaning the bait, and whereby its life is increased.

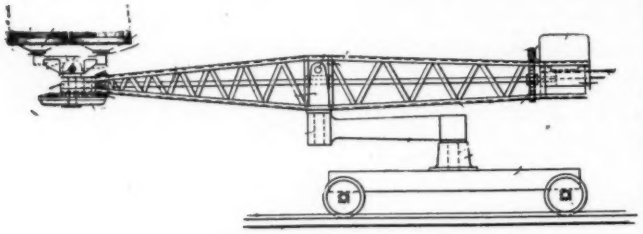


The bait consists of a glass engaging portion of a metal with its coefficient of expansion substantially the same as that of glass. This glass engaging portion preferably consists of a composition with a low carbon iron content of 55 per cent, and a nickel content of 45 per cent, but it will be understood that the invention is not limited to the use of these elements or to the proportions stated. Since the metal and the glass which welds thereto have the same coefficient of expansion, the glass article will never crack from the bait due to changes in temperature or to the gradual cooling as the drawing progresses. The glass article may, therefore, be drawn to any desired length without danger of breaking.

Brush for Cleaning Glass-Making Pots. U. S. 1,349,262. August 10, 1920. Clarence M. Brown, of Philadelphia, Pa., assignor to Pittsburgh Plate Glass Company, a corporation of Pennsylvania.

This invention relates to cleaning brushes and more particularly to that class of brushes used in cleaning cinders and other foreign particles from the exterior of clay pots used in the manufacture of plate glass.

In the manufacture of plate glass, clay pots are filled with glass batch and then placed in a melting furnace until the batch in the pots has become properly melted and refined, after which preparation the pot is removed and carried by a crane to the

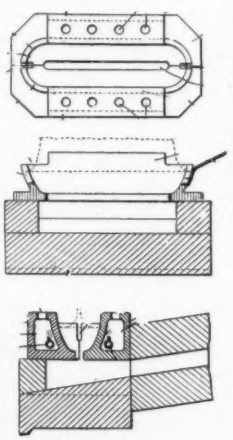


casting tables. It is the purpose of this invention to provide a portable cleaning brush as shown in accompanying cut, whereby the brush may be moved to various points in the factory for the purpose of cleaning the pots carried to the various casting tables, thereby saving considerable travel of the teeming crane.

The operation of the apparatus is as follows. When a pot has been removed from the melting furnace, it is picked up by the crane which is provided to carry the pot to the casting table. The furnaces are constructed so that a large number of pots may be accommodated at one time and these pots are removed from the furnace at various places. The truck is therefore moved to a position adjacent the place from which the pot is to be removed. After the crane has picked up the pot, the operator immediately adjusts the brushing mechanism so that the brushes are beneath it and so that the brushes come in contact with the bottom of the pot. This movement of the brushes is readily accomplished because of the mounting for universal movement of the beam. It will be seen that the brushes may be made to cover a considerable field without moving the truck.

Apparatus for Drawing Glass Sheets. U. S. 1,349,201. August 10, 1920. Halbert K. Hitchcock, of Pittsburgh, Pa., assignor of one-half to Hitchcock Experiment Company, a corporation of New Jersey.

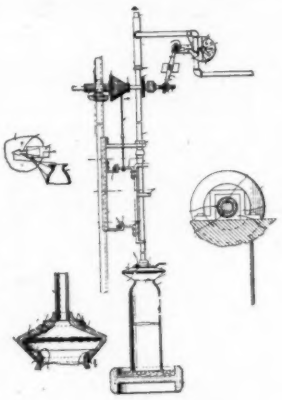
The invention relates to apparatus for drawing of glass sheets and particularly to that part of the apparatus from which the sheet is generated. The invention has for its principal objects, as will be seen from the accompanying illustration the provision of a drawing receptacle, (1) adapted to secure a greater degree of cooling at the edges, which cooling permits the formation of thicker edges, assists in holding the glass flat, and counteracts the normal tendency of the sheet to draw in and narrow in width as the drawing of the sheet progresses, and (2) adapted to secure a better adhesion between the sheet at its edges, also tending to prevent a narrowing of the sheet at the line of generation of the sheet.



Since the edges of a sheet being drawn radiate the heat more rapidly than the central portion thereof, the sheet normally tends to buckle due to the unequal cooling and correspondingly unequal contraction. With the thickened edges as produced by the present apparatus this difficulty is overcome in that the thickened edges, produced by the rapid cooling at the initiation of the draw, contain a greater amount of heat in proportion to their radiating surfaces than the body of the sheet. As a result the temperature is more uniform from edge to edge than is the case with a sheet of uniform thickness from edge to edge.

Glass-Drawing Apparatus. U. S. 1,351,833. September 7, 1920. George L. Catlin and David Morrison, of Port Allegany, Pennsylvania, assignors to R. W. Hilton, of Smethport, Pennsylvania.

This invention relates to glass drawing furnaces, and particularly to the bait, the means for lifting the bait, and the means for controlling the volume and pressure of air in the bait.

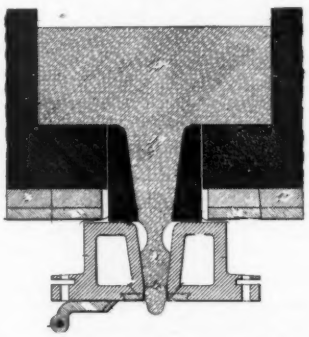


Some of the objects of this invention are to provide a bait of a peculiar form so designed that it will not obstruct observation of the point at which the bait touches the surface of the glass as the bait merges from the glass, to thus permit the workman to observe the condition of the glass as it is initially drawn upward from the pot; to so construct the bait that the novel will have a better engagement with the bait than is ordinarily the case; to provide means for controlling the pressure of the air within the bait, and therefore the pressure within the cylinder of glass drawn by the bait, this means comprising a valve on the bait itself; to provide means for controlling the pressure ir the bait, the cylinder, and bait pipe, and means for keeping a volume controlling valve in alinement with the bait pipe or tube.

A further object is to provide an improved form of cage or carriage for supporting the bait pipe and a shiftable winding drum which will keep the cable and winding drum centered at all times. Other objects also are set forth in detail.

Apparatus for Gathering Molten Glass. U. S. 1,353,953. September 28, 1920. Joseph B. Graham, of Evansville, Indiana, assignor to the Owens Bottle Machine Company of Toledo, Ohio, a corporation of Ohio.

In this invention a two part receptacle is employed having a removable bottom provided with a cut-off. Said bottom, however, is withdrawn during the accumulation of a charge in the receptacle, leaving the accumulating charge temporarily supported by the side walls of the receptacle for a substantial period of time before said walls are separated to drop the charge into the mold. While the charge is thus supported after the bottom has been withdrawn the lower surface of the mass is given opportunity to be reheated from the interior of the mass, whereby the surface chilling is overcome and the charge received into the forming mold in suitable condition to assume the form of a mold. The reheating also serves to remove the scar ordinarily formed by the cut-off.



Glass Factory Equipment and Supplies

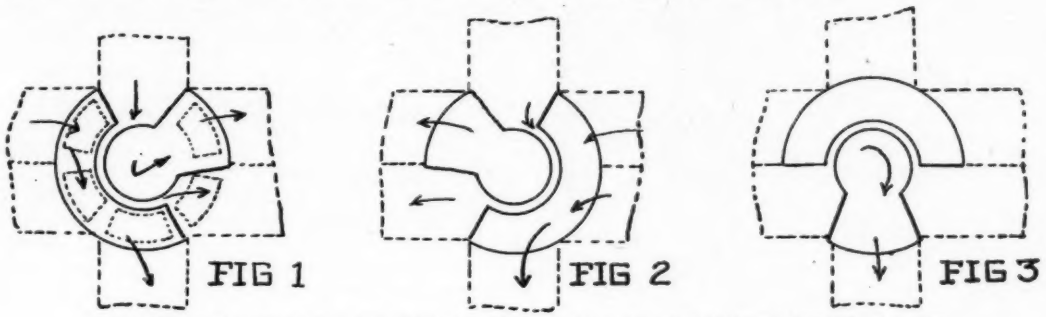
SPECIAL FEATURES DESCRIBED FROM DATA SUPPLIED PRINCIPALLY BY THE MANUFACTURERS

New Gas and Air Reversing Valve

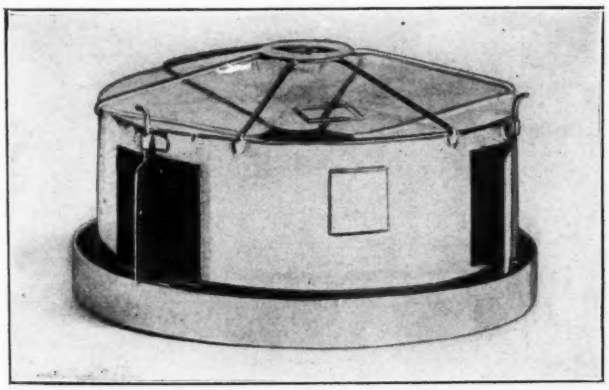
A gas and air reversing valve constructed upon principles not heretofore utilized in devices of this kind has been invented by William G. Bergman, of the McCamic-Batchell-Bergman Company, Toledo, Ohio, who has applied for a patent covering the new features.

As set forth in the patent application, the invention has for its object the production of "a simple and yet efficient gas and air reversing valve and one which will occupy comparatively a small floor area and which may be so manipulated that it may be used not only to reverse the direction of gas and air to and from sources of supply of the gas and air and the consuming instrumentality thereof, but also may be so adjusted or positioned that it will permit the flow of gas directly from the source of supply to a delivering means such as a stack, particularly, for burning out any deposits such as soot that may accumulate in the main or keeping the air and gas reversing valve cool to prevent burning and warping of the valve."

The valve is constructed with a number of chambers which communicate with subterranean passageways leading to and from the sources of gas and air supply and the furnace and stack. The position of the valve with reference to the passageways determines the direction of the flow of air and gas. By rotating the valve 120 degrees, as shown diagrammatically in Figs. 1 and 2, the flow is reversed.



DIAGRAMS SHOWING THE METHOD OF OPERATING THE BERGMAN REVERSING VALVE

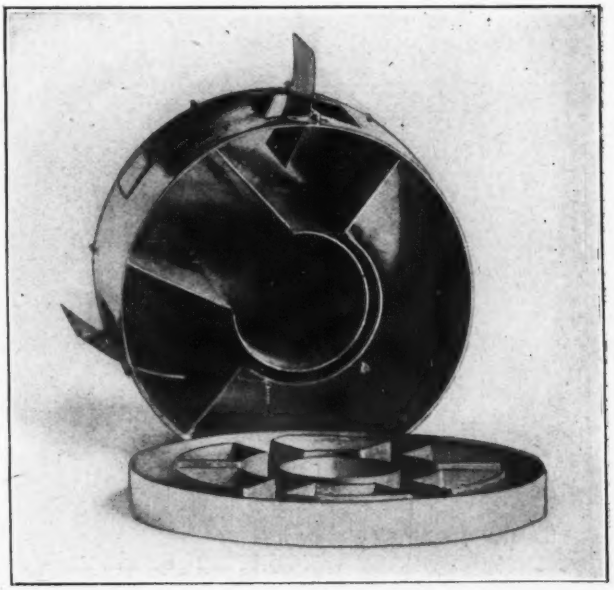


FULL VIEW OF THE BERGMAN REVERSING VALVE

may accumulate in any device through which the gas may pass to and from the valve. It also has for its object to provide a reversing valve which may be manipulated with the least loss of gas and moreover is so constructed that in the operation of the valve the movement of the air will be controlled as well as the movement of the gas and so that upon a single operation of the reversing valve, air and gas cannot commingle before they are discharged in the consuming device, such as a furnace, whereby explosions that sometimes occur in connection with reversing valves now known in the art, are entirely prevented.

"The invention also has for its object to provide a means for

The valve may be used not only for reversing the direction of the air and the waste gas through the checker work and the furnace, but also it may be used for burning out the passageway for the producer gas or directly connecting the passageways



VIEW SHOWING CONSTRUCTION OF THE BERGMAN REVERSING VALVE

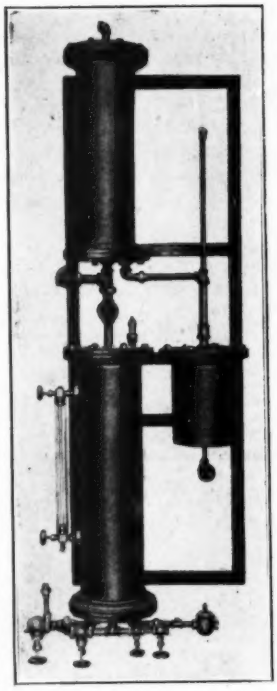
that lead to and from the valve. The position of the valve in the burning out operation is illustrated in Fig. 3. The valve is located so as to directly connect the source of gas supply with the stack. The gas main may thus be burned out by opening suitable doors to admit air, which mixing with the gas will ignite, and the soot and other material deposited from the gas in the gas main will be burned out.

Distilled Water for Mixing Silver

It is an accepted fact in mirror manufacturing that the purer the water which is used in making the silver mixture, the finer the mirror is which results. In this connection The Griscom-Russell Company, 90 West street, New York, call attention to the water distilling evaporator set manufactured by them, which is shown in the accompanying illustration.

This set consists of a small evaporator, to the coils of which boiler steam is applied. The shell of the evaporator contains city water and by the condensing of the steam in the coils this water is evaporated and the vapor is then led to the distilled unit, where it is condensed and is ready for use in the silver mixture. The distilled water secured by this apparatus is stated by the manufacturers to be of great purity. This equipment is kept in stock by the manufacturers for immediate shipment.

The Griscom-Russell company also manufactures the G-R water and oil strainer for removing foreign matter from oil lines.



DISTILLED WATER EVAPORATOR SET

Conserves Heat, Promotes Comfort

To keep the heat in the furnace or oven and the cold air out, without interfering with the operation of the furnace, is the purpose for which the Wiegand patent chain screen here illustrated is manufactured. This screen, when suspended over a furnace opening, makes a flexible, easily penetrable shield, protecting the operatives from extreme heat and glare while engaged in changing pots, feeding tanks and similar occupations.

THE WIEGAND PATENT CHAIN SCREEN

A Wiegand screen consists of a series of individual strands of steel chain suspended close together from a steel bar so as to form a continuous sheet or curtain of chain, likened by the manufacturer to the familiar Japanese portiere and offering, comparatively, no more resistance to the passage of tools or other objects projected into the furnace than does the Japanese portiere to the passage of a child. Looking through the holes in the links of chain, the operator enjoys a better view of the interior of the furnace than could be obtained if the screen were eliminated, the heat and glare being toned down to an endurable degree.

The screens are especially made to purchasers' dimensions and various methods of mounting them are employed, according to the necessities of each particular case.

The manufacturers, E. J. Codd Company, 704 South Caroline street, Baltimore, Md., claim that this device, already installed and in successful operation in a number of glass works and in hundreds of other plants, saves heat, increases the efficiency of the workman, reduces eye strain and promotes the comfort of the furnace operatives.

Virginia Emery for Grinding Glass

Samples from deposits of high grade emery discovered in Virginia during the war by a New York abrasive manufacturer and submitted by the U. S. Geological Survey to the Bureau of Standards for a series of tests elicited a report showing the material to possess qualities equal in general and superior in several respects to those of imported Turkish emery, which hitherto has had the reputation of being unequalled by any domestic product. The report follows:

Department of Commerce, Bureau of Standards—Report on Abrasive for Glass Grinding No. 60, 120, 180, 275—Submitted by U. S. Geological Survey, Washington, D. C.

Request dated June 19, 1918.
Material received June 19, 1918.

Extended tests of (emery) abrasive for glass grinding, No. 60, 120, 180, 275, have given the following results:

1. Each grade of material proved of high degree of uniformity of size of particle and uniformity of hardness, giving a very rapid and regular grinding action equaling in every point the best of available Turkish emerys.

2. Each grade of particle was found to break up successively into generally equal sized particles of spherical shape and obtuse angles: usually a single particle breaking into two equal sized particles, etc.

3. Condition of the surface left by each grade was consistently found to be equally satisfactory as that produced by Turkish emery for precise optical surfacing.

4. Each grade submitted was found to remain sharp and nearly its original size equally well as, and finer grades better than, the corresponding grades of Turkish emery, and has rather a faster cutting action.

5. Each grade submitted was found to be of particles harder and more brittle than corresponding grades of Turkish emery. The effect of particles very closely resembled, in their grinding action on the glass, the effect of a spherical steel ball under pressure rolling on smooth surface of ice; the reduced material coming off in thin flakes approximately parallel to surface at the point of contact.

6. Each grade was found to be approximately one-half to two-thirds as fast as corresponding grades of carborundum, and aloxite or alundum.

7. Surfaces produced by each grade submitted do not have deep or irregular pits of wide range of sizes as is produced by carborundum, alundum, aloxite, etc.

It may be stated that the above tests have been conducted during the past year with as nearly as passible identical conditions for working of the material submitted, Turkish emery, Greek emery, other natural emery, carborundum, alundum and aloxite, also crushed steel, sand, etc., in working with the same kinds of glasses, tools, speeds of working, pressures of tools on abrasive, amounts of abrasive and water, etc., in the standard processes of commercial lens grinding, i. e., of spectacle lenses, etc., and the precision processes for highest grade lenses and prisms for instrument use.

Also it is stated all work in tests was conducted on strictly modern machinery, some of a distinctly special nature for precise optical work. Also each point of test was made strictly consecutive or simultaneous, i. e., test blocks of glass were made from the same sheet of glass, same per cent of weight of abrasive to water used, same time of grinding with the same pressures, speeds, kinds of tools, conditions of laps, etc., and done within one comparatively short period of time by one and sometimes three equally qualified persons of the permanent personnel of the optical shop. In no instance was a judgment made from memory of what happened the day before, but was based solely upon the simultaneous results with all materials, conditions, etc., concerned.

It is to be stated that the grinding action as noted above, i. e., of a steel ball on ice, is that characteristic of natural emerys, particularly of the Turkish emerys which have always given such pronounced satisfaction in the past. Also that this grinding action is very characteristically different from the reducing action of the acute angled, sharp-edged, diamond hard particle of carborundum, whose action is that of a wedge making deep scoring cleavage lines or prying out irregular chunks from the glass surface; in many instances the glass wedged loose being as much as ten times the size of carborundum particle. Most artificial abrasive simulates the action of carborundum.

It is to be recommended that from results found for abrasive submitted for purposes of grinding of glass for special purposes, further reduction of the material to finer grades than No. 275 should be made even up to the 10 F grade.

No facilities at present or during the past year have been available for tests of abrasive in wheels for metal grinding.

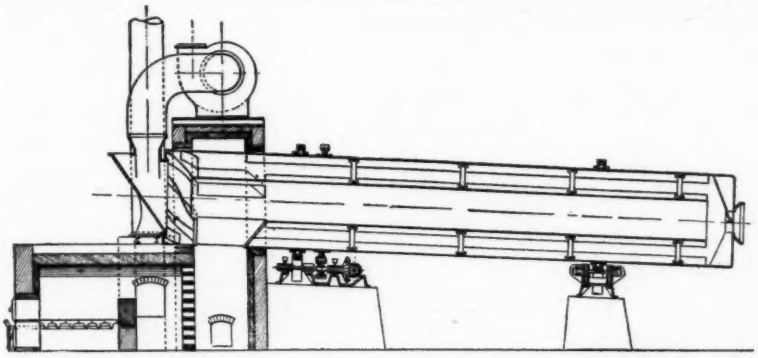
(Signed) S. W. STRATTON, Director.

Washington, D. C., May 13, 1919.

According to A. H. Pritchard, of the Niagara Emery Mills, Inc., deposits comprising over 800 acres of emery like that submitted to the Bureau of Standards were located by himself and other representatives of his company after long and arduous prospecting through many different districts. This search was prompted by the scarcity of high grade emery due to the cessation of importations from Turkey after the war broke out. After extended laboratory and factory tests the new material was put on the market under the name of Khasia Brand emery. The Niagara Emery Mills, Inc., 50 Broad Street, New York, who also handle Turkish emery, are exclusive miners and manufacturers of the Khasia Brand and state that it has been in successful use in a number of factories during the past two years.

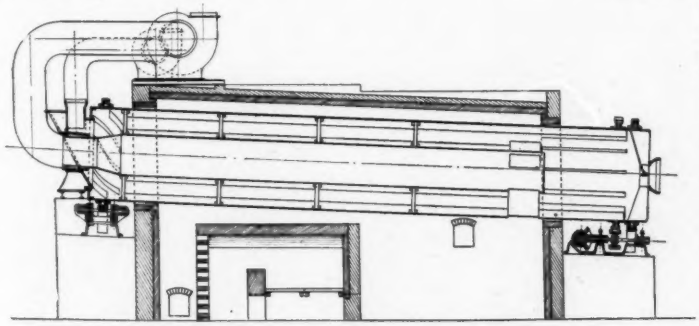
The Christie Sand Dryer

Excessive moisture in glass sand at the time it goes into the batch is a frequent source of trouble, due to the water displacing an equal weight of sand in the batch weighing scales, thus changing the proportions of the mixture, diminishing the actual content of sand in the batch and causing an excess of soda ash and other ingredients.



SECTIONAL VIEW, DIRECT HEAT TYPE

Difficulties of this kind have been multiplied of late by the practice of shipping sand in open cars and this has led a number of manufacturers to investigate the efficiency of modern types of sand drying apparatus.



SECTIONAL VIEW, INDIRECT HEAT TYPE

The Christie Sand Dryer is claimed by the manufacturers, The L. R. Christie Company, 307 Fourth avenue, Pittsburgh, Pa., and illustrated here, to be designed in such a way as to utilize fuel most economically. Two types, direct heat and indirect, are manufactured.

In the direct heat machine the furnace gases are applied first to the wet material, but do not come in contact with same until they have passed the entire length of the central flue, during which time any unconsumed carbon or volatiles are completely burned, so that the discoloration of the sand, if any, is very slight, and not objectionable for some kinds of glass. With this type of machine, efficiency of 85% has been shown; that is, 85% of the B. T. U. value of the fuel was used for doing necessary work. The following figures will possibly be of interest and make this point clear. Washed sand ordinarily will run about 10% moisture, that is 2,000 lbs. of sand, dry weight, will contain 222 lbs. of water, and in order to evaporate, it is necessary to not only heat the water to the evaporation point, 212° F., but also the sand to the same temperature. Assuming the initial temperature at 62%, this means an elevation of 150° F. The heat requirements, therefore work out as follows:

2,000 x 150 x .21	= 63,000	B. T. U. to heat material
222 x 150	= 33,300	" " " " water
222 x 970.4	= 215,500	" " " " evaporate the water
	311,800	total B. T. U. required.

Assuming coal at 14,000 B. T. U. thermal value to the pound, this would represent a fuel consumption of 22.3 lbs. of coal per ton of dried material, and at an efficiency of 85%, the actual fuel consumption would amount to 26.25 lbs. of coal per ton of dried material. It must be borne in mind that this is based on evaporating from 10%. In many instances the moisture will be considerably less than this, and the fuel consumption very nearly proportionate, although not exactly, because the quantity of heat consumed in heating the sand remains constant

For some sands it is absolutely essential that there be no chance of the slightest discoloration and for this purpose it is necessary to use the indirect-heat type of dryer. With this apparatus, due to the indirect application of heat, the efficiency will run about 70%, making the fuel consumption 31 85 lbs. of coal per ton of dried material on the same basis as above.

The indirect heat type has a further advantage in that the flow of air passing through the drying compartment can be so controlled that there will be little trouble from dust losses, which is desirable in some instances when drying fine sand.

Trade Publications

The Sharp-Schurtz Company, Lancaster, O., consulting glass chemists and engineers, is issuing its house organ, *Double S Fax*, in loose leaf form, a very convenient arrangement for those who desire to classify data of various kinds in such a way that it can be located readily when needed. Leather binders for the loose leaves may be obtained from the publishers.

Valuable information on arsenic and its use in glass manufacturing and other data has already been issued and additional pages will be published from time to time. Those interested in the manufacture of glass will find *Double S Fax* of interest and value, and may obtain copies of all pages issued to date from the publishers and have their names placed on the mailing list to receive additional installments as issued.

THE GLASS INDUSTRY will be glad to publish in this department descriptions of new and useful devices, machinery and supplies of interest to the glass manufacturing trade.—ED.

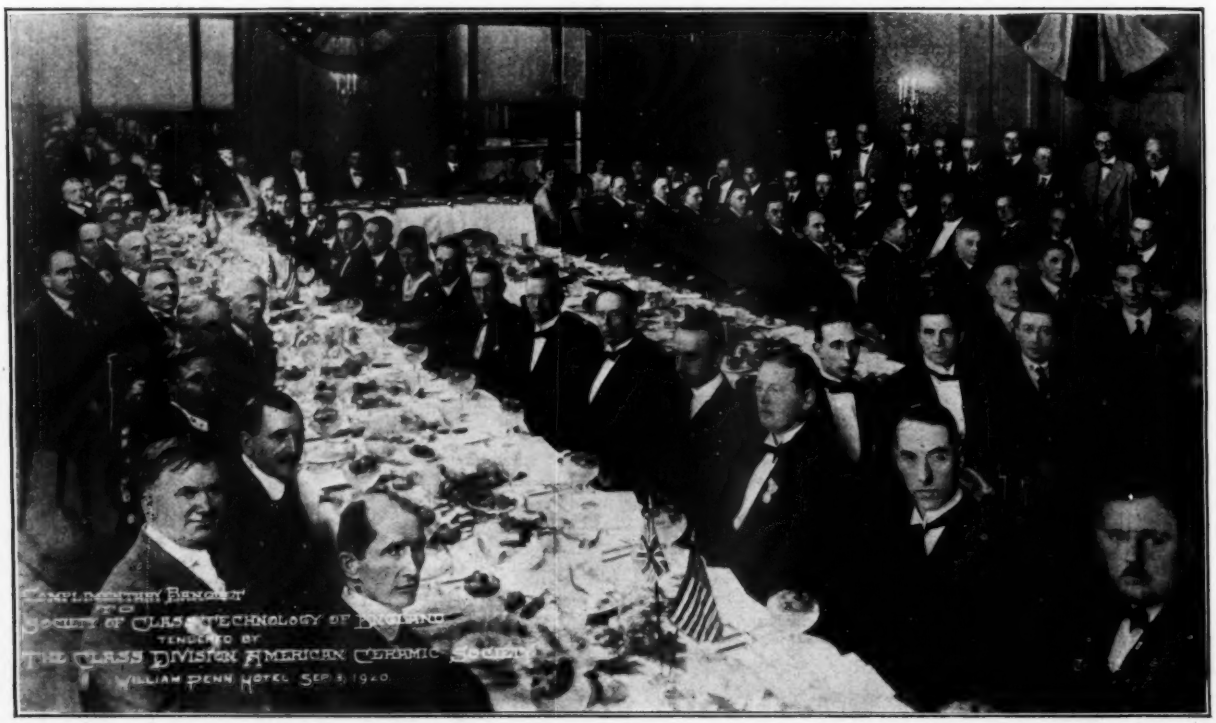
Entertaining the Society of Glass Technology

The cordial reception accorded by American glass manufacturers and technical men to the delegation of British glass chemists and manufacturers who, under the leadership of Prof. W. E. S. Turner, of the School of Glass Technology, University of Sheffield, and at the invitation of the Glass Division of the American Ceramic Society, recently made a four weeks' tour of inspection of the principal glass manufacturing districts of the United States, will undoubtedly be remembered for many a day by the visitors from overseas. From the day they arrived at New York until the completion of their trip, the friendly attitude of the trade was demonstrated in many practical ways.

Members of the party expressed themselves as overwhelmed by the cordiality of their reception and amazed at the large scale operations and marvelous automatic machinery employed in the American factories. What they learned here will undoubtedly have a far-reaching effect on the future of the British glass industry.

E. Ward Tillotson of the Mellon Institute of Industrial Research, secretary of the Glass Division, was the official guide and representative of the American Ceramic Society throughout the trip and other prominent glass men also gave their services freely in the interests of the trade and for the sake of good international relations, to make the occasion successful. Those attending the banquet held at the William Penn Hotel, Pittsburgh, Pa., on September 3rd, were:

Thomas W. McCreary, Phoenix Glass Co., Monaca, Pa.
William P. Clark, Toledo, Ohio.
J. Woolford, sec'y National Flint Glass Workers, Society, Manchester, England.
E. Allen, Newcastle-on-Tyne, England.
A. Dodds, Sowerby's Ellison Glass Works, Ltd., Gateshead-on-Tyne, England.
R. Hodgson, Gosforth, Northumberland, England.
Wm. J. Miller, Swissvale, Pa.
T. F. Emminger, Pittsburgh Clay Pot Co., Pittsburgh, Pa.
A. E. Gray.
A. W. Kimes, *National Glass Budget*, Pittsburgh, Pa.
William Lamont, Key Glass Works, London, England.
C. T. Garbutt, Sowerby's Ellison Glass Works, Gateshead-on-Tyne, England.
George D. Willetts, Pittsburgh, Pa.
G. P. Ogale, University of Sheffield, England.
A. H. Goodman, Pittsburgh, Pa.
Dr. W. E. S. Turner, Dept. of Glass Technology, University of Sheffield, England.
Dr. S. B. McCormick, Chancellor of University of Pittsburgh, Pittsburgh, Pa.
H. L. Dixon, Pittsburgh, Pa.
S. R. Scholes, Utility Glass Co., Lonaconing, Md.
C. W. Brown, Pittsburgh Plate Glass Co., Pittsburgh, Pa.
J. S. Herron, president, Pittsburgh City Council.
Mrs. H. L. Dixon.
Miss Esther Gass, The Haugh, near Bolton, England
Mrs. H. H. Asquith.
Mrs. J. R. Johnston, Jr.
Mrs. H. G. Dixon.
Mrs. H. Noel Clark.
Mrs. J. A. Osler.
Mrs. T. F. Harnack.
G. P. Gass, The Haulgh, near Bolton, England.
W. A. Yung, Westinghouse Lamp Works, Harrison, New Jersey.
E. W. Tillotson, Mellon Institute, Pittsburgh, Pa.
H. W. Seldon.
H. O. Pringle.
H. J. White, H. L. Dixon Co., Pittsburgh, Pa.
T. F. Harnack, H. L. Dixon Co., Pittsburgh, Pa.
C. R. McCann, H. L. Dixon Co., Pittsburgh, Pa.
V. G. Greene, Swissvale, Pa.
R. M. Kimball, Pittsburgh, Pa.
T. A. Kimes, *National Glass Budget*, Pittsburgh, Pa.
H. G. Dixon, H. L. Dixon Co., Pittsburgh, Pa.
C. H. Blumenauer, Jefferson Glass Co., Follansbee, W. Va.
J. R. Johnston, Jr., Pittsburgh, Pa.
A. H. Chandler, Pittsburgh Plate Glass Co., Pittsburgh, Pa.
S. Stafford, Pittsburgh, Pa.
J. C. Hostetter, Steuben Glass Works, Corning, New York.
A. D. Terry, secretary, Chamber of Commerce, Pittsburgh, Pa.
C. D. Spencer.
E. B. Gillinder, Philadelphia, Pa.
L. W. Nichols, Rochester, Pa.
W. S. Williams, Rochester, Pa.
W. J. Rees, Dept. of Refractory Materials, University of Sheffield, England.
D. W. Ross, Findlay Clay Pot Co., Washington, Pa.
C. E. Fulton, Pittsburgh Plate Glass Co., Creighton, Pa.
C. W. Parmalee, University of Illinois, Urbana, Illinois.
Wm. M. Clark, Nela Park, Cleveland, Ohio.
George J. Eibel, *National Glass Budget*, Pittsburgh, Pa.
J. M. Hammer, Pittsburgh, Pa.
W. C. Snowdon, University of Sheffield, England.
H. A. Bateson, Bateson Bros., Liverpool, England.
Louis Reizenstein, Pittsburgh, Pa.
A. Silverman, University of Pittsburgh, Pittsburgh, Pa.
H. Noel Clark, Beatson, Clark & Co., Ltd., Rotherham, England.
T. C. Sutcliffe, J. W. Sutcliffe & Co., London, England.
J. Oliver Challinor, U. S. Glass Co., Pittsburgh, Pa.
C. E. Towers, Lewis & Towers, London, England.
H. H. Asquith, Redfern Bros., Ltd., Barsley, England.
Duncan Webb, Jr., Molineau, Webb & Co., Ltd., Manchester, Eng.
A. Lambert Foster, Fletcher's Sauce Co., Ltd., Selby, England.
J. G. Bryce, U. S. Glass Co., Pittsburgh, Pa.
W. B. Mitchell, Fletcher's Sauce Co., Ltd., Selby, England.
J. W. Cruikshank, Pittsburgh, Pa.
Miss Cruikshank.
W. Butterworth, Jr., Butterworth Bros., Ltd., Manchester, England.
Sven Fogelberg, Kosta, Sweden.
B. D. Varshnei, University of Sheffield, England.
J. L. Crawford, Mellon Institute, Pittsburgh, Pa.
W. Atack, University of Sheffield, England.
A. H. Stewart, Phoenix Glass Co., Monaca, Pa.
H. Gregg, Gregg & Co., Knottingly, England.
I. G. Kaufman, *The Glassworker*, Pittsburgh, Pa.
C. D. McArthur, Pittsburgh, Pa.
R. F. Farmer, Pittsburgh, Pa.
H. W. Pai, University of Sheffield, England.



TRADE NEWS

The Stirling Glass Company, Elmira, N. Y., which was organized as a temporary holding company for the purchase of stock of other companies, has been dissolved.

David Pugh, general manager of the recently organized Tri-State Glass Company, Toledo, O., announces that they expect soon to begin manufacturing operations at the plant of the old Toledo Bottle Company.

The election of officers of the Johnston Brokerage Company, held at a meeting of the board of directors, at Pittsburgh, Pa., resulted as follows: L. S. Cunningham, president; J. R. Johnston, Jr., vice-president; Paul E. Cunningham, secretary; C. C. Nelson, treasurer; J. A. Doyle, assistant secretary-treasurer, and C. S. Lewis, assistant secretary-treasurer.

The Hazel-Atlas Glass Company, Wheeling, W. Va., are increasing the capacity of their glass and sand plant at Great Cacapon, W. Va., through the opening up of two additional quarries. These new quarries will converge into the present grinding and washing plant and will increase the company's supply of rock and enable them to operate their present grinding plant at capacity.

A. J. Fallen, secretary of the Davies Glass Company, Wheeling, W. Va., reports work is progressing on their new plant which occupies the site of the old Superior Glass plant. Carl W. Shimp, contractor, is in charge of the work. The plant will be equipped with a sixteen pot furnace, a fifteen ton continuous tank and four day tanks. Illuminating glassware will be the chief line of production and producer gas will be used as fuel.

The Interstate Window Glass Company of Pittsburgh, Pa., has secured a charter from the Secretary of State of West Virginia and has been capitalized at $4,000,000. The following men are interested in the project: E. E. Gallup, T. W. Camp and G. W. Mitchell of Smethport; H. J. Walter, Bradford, Pa.; W. S. Calderwood, Kane, Pa.; T. S. Koblegard, Weston, W. Va.; C. L. Suhr, Oil City, Pa.; and Charles Wandless, Lancaster, Ohio.

Chief Engineer H. E. DeVaughn of the United States Window Glass Company, Morgantown, W. Va., according to a press report, was recently in Shreveport, La., in conference with officials of the M. K. & T. railway and others interested, for the purpose of arranging details for the building of a new factory. The new factory is to be located in Jewella and it is reported that it will rank among the large enterprises of the kind in the country. The amount to be expended in the building of this factory, it is announced, will total about $1,000,000.

The Crystal Glass Casket Company, Washington, D. C., has purchased four fireproof buildings on the Kanawha River Drive in Area M. at Nitro, W. Va. A. B. Lacey is president of the company; R. A. Howe, vice-president; Edwin C. Reed, secretary and treasurer, and Crandall Mac Kay, general counsel. When equipment is installed the new plant is expected to produce glass caskets at the rate of sixty tons a day and is particularly intended to supply the trade in the District of Columbia, Delaware, Maryland, Virginia, West Virginia and Kentucky. The date for starting operation is uncertain.

Construction is progressing on the new $3,000,000 glass factory of the Illinois Glass Company at Bridgeton, N. J. Keeley Brothers Construction Company of East St. Louis, Ill., Alexander Godfrey, general manager and chief engineer, has the work in charge. The plant will consist of several units. One factory and lehr room of re-inforced concrete with steel roof will measure 330 by 700 feet and the estimated cost of this unit is $2,000,000. The producer building will consist of two units, 50 by 150 feet, and will be built of reinforced concrete at an estimated cost of $500,000. The engine and boiler room and batch house, also of reinforced concrete, will be 50 by 100 feet, with a height of 40 feet, the estimated cost being $500,000.

The Elite Glass Works, Bellaire, O., has been reorganized and taken over by the Elite Glass Works Company. The company has been formed under Ohio laws with a capital of $50,000. The new company is operating two plants. One at 2700 Washington street, Factory D, where they are turning out a high class line of carved gold, blown lemonade sets and a general line of tableware in all decorations. At Factory C, 3600 Monroe street, where the general offices are also located, a general line of artistic cutting in medium and high priced goods is made. Officers of the company are: President, Robert Engelhardt; vice-president, C. F. Neugart; secretary and general manager, C. O. Myers; treasurer, L. H. Buches. The concern is one of the largest glass decorators and cutters in the Bellaire section of the Ohio Valley.

Reports from Indianapolis, Ind., state that the general depression being felt in many lines of business in Indiana is not being experienced by the Hoosier glass industry. Without exception the glass plants of Indianapolis and other Indiana cities report not only a continuance of the business they have been having, but increased demand.

Orders for window glass are far in excess of the present capacities of the plants. There has been a slight let up in the demand for plate glass, as the automobile industry to some extent has discontinued purchases.

One of the largest glass counters ever manufactured is now being made for the city market of Cleveland by the Marietta Glass Manufacturing Company, Indianapolis. The counter is 1,500 feet long and is made of the white glass in which this company specializes. Demand for glass lunch room fixtures, especially in industrial plants, is very large at this time, L. Burgess, secretary and treasurer of the Marietta company reports.

The Fairmount Glass Works, Indianapolis, doubled its capacity during the summer months. The bottle business in which this firm specializes is exceeding all previous periods. The increased capacity of the plant will scarcely take care of the orders now booked.

The car shortage seems to be the only bugbear in the way of the Indiana glass trade. Most of the plants are consumers of West Virginia coal and this is extremely hard to get in Indiana. The glass plants are also having trouble in obtaining sufficient sand because of the car shortage.

The General Electric Company and the Westinghouse company are both entering Indianapolis with factories for the manufacture of electric light bulbs. Sites have been obtained and the new buildings are expected to be completed during the winter or in the early spring.

Personal

DR. C. H. KERR, who for a considerable period has been connected with the American Optical Company, Southbridge, Mass., as research manager, will be leaving that concern early in November to become associated with H. L. De Zeng in the management of the De Zeng-Standard Company, Camden, N. J., the oldest and largest manufacturers of diagnostic instruments for use by eye, ear, nose and throat specialists.

Financial Report

At the annual meeting of the stockholders of the American Window Glass Company, at Pittsburgh, Pa., October 19, 1920, the following financial report covering operations during the fiscal year was submitted:

GENERAL BALANCE SHEET, AUGUST 27, 1920.

ASSETS.

Cash, Notes and Accounts Receivable	$5,190,926.81
Finished Product, Materials and Supplies (at cost)	3,403,294.10
Freight, Taxes and Insurance paid in advance	66,983.19
Plants, Real Estate and Good-will	19,455,841.68
Investments	71,059.41
U. S. Liberty Bonds and Treasury Certificates	1,572,250.00
Treasury Stock	5,000.00
Deferred Charges:	
Discount on Bonds, etc	49,587.70
Total	$29,814,942.89

LIABILITIES.

Accounts Payable for Materials, Wages, etc	$869,814.26
Employees' Subscriptions for Liberty Bonds	8,275.68
Taxes Accrued not due	2,165,170.11
Interest on First Mortgage Bonds Accrued not due	2,311.14
Preferred Stock Dividend Payable Sept. 1, 1920	140,000.00
Royalty Payable	419,161.50
First Mortgage & Collateral Trust 6% Sinking Fund Gold Bonds, due Feb. 1, 1922	525,000.00
Reserve—	
For Depreciation of Plants and Equipment and Doubtful Accounts and Notes Receivable	1,710,409.98
Preferred Capital Stock	4,000,000.00
Common Capital Stock	13,000,000.00
Profit & Loss—Surplus	6,974,800.22
Total	$29,814,942.89

SUMMARY OF INCOME AND PROFIT AND LOSS FOR PERIOD ENDED AUGUST 27, 1920.

Net Profit from Operations		$7,338,323.38
Other Income		2,041,186.84
Total Income		$9,379,510.22
Deductions from Income:		
Reserved for Federal and State Taxes	$1,922,835.62	
Royalty	2,453,817.03	
Other Charges	464,900.24	
		4,841,552.89
Surplus for Year		$4,537,957.33
Surplus, August 29, 1919		$4,146,415.89
Total Surplus		$8,684,373.22
Deductions from Surplus:		
Dividends on Preferred Stock	$279,650.00	
Dividends on Common Stock	1,429,923.00	
		1,709,573.00
Surplus, August 27, 1920		$6,974,800.22

The following directors were re-elected: Arthur E. Braun, George M. McCandless, William L. Monro, James D. Callery, H. N. Van Voorhis, Thomas F. Hart and George C. Moore. The board of directors re-elected the present officers as follows: President and general manager, William L. Monro; vice-president, A. E. Braun; treasurer, Willard A. Esselstyn; secretary and assistant treasurer, Robert M. Speer.

Stock Quotations

(Reported by Moore, Leonard & Lynch, Frick Building, Pittsburgh, Pa.)

New York, October 28.

	Bid	Asked
Libbey Owens Sheet Glass, common	165	172
Libbey Owens Sheet Glass, preferred	102	106
Owens Bottle Machine, common	53	58
Owens Bottle Machine, preferred	104	111

Pittsburgh Stock Exchange

Report of sales from October 22 to 28, inclusive.

Shares		High	Low	Last
785	Am. Window Glass Mch., common	122	115	117¾
75	Am. Window Glass Mch., preferred	87	87	87
175	Am. Window Glass, preferred	100	100	100
100	Pittsburgh Plate Glass	157	154	154

United States Glass, 55½ asked.

Wheeling Exchange, October 28.

	Bid	Asked	Last
Fostoria Glass Co	106	108½	108½
Hazel-Atlas Glass Co	185	188	187½
Imperial Glass Co	90	95	90

Current Prices of Glass-Making Materials

From quotations furnished by various manufacturers and dealers

Alumina-Oxide	lb.
Alumina-Hydrate	lb. .12 to .14
Antimony Oxide 98%	700 lb. bbls., per lb. 13.5 to 14.5
Arsenic Trioxide, Dense, White 99%	650 lb. bbls., per lb. .14 to .16
Barium Carbonate	$50.00 per carton to per lb. .06 to .06½
Barium Hydrate	lb. .07½
Bone Ash	lb. .10 to .10½
Borax	lb. .09
Borax, Fused	lb. .22
Boric Acid, Fused	lb. .17
Cadmium Sulphide	lb. 1.60 to 2.50
Feldspar (Powdered)	per ton 20.00 to 21.00
Fluorspar	per ton 50.00 to 70.00
Kaolin, washed, pure white	per ton 15.00
Kryolite	lb. .15
Lepidolite (finely ground, 40% lithium oxide)	ton 60.00
Litharge (PbO)	lb. .15 to .16
Manganese, 85% MnO_2	lb. .05
Potassium Carbonate, 80-85%	lb. .20
Potassium Nitrate	lb. .14
Powdered Blue, 6% CoO—500 lb. lots,	per lb. .28
Salt Cake	per ton 48.00 to 50.00
Selenium	lb. 2.00 to 2.50
Soda Ash—58% dense (f. o. b. Works, 1921 delivery, 48% basis)	Bulk, 1.80; in bags, lb. 1.95 to 2.15
Sodium Nitrate	lb. .06 to .14
Sodium Selenite	lb. 1.60
Sulphur (Flowers)	lb. .04¾
Uranium Oxide, Yellow	lb. 2.25
Uranium Oxide, Black	lb. 3.25
Zinc Oxide (ZnO)	lb. .12 to .18

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